NATIONAL CENTER FOR EARTH-SURFACE DYNAMICS

A NATIONAL SCIENCE FOUNDATION SCIENCE & TECHNOLOGY CENTER

CHAPMAN CONFERENCE

Source to Sink Systems Around the World and Through Time

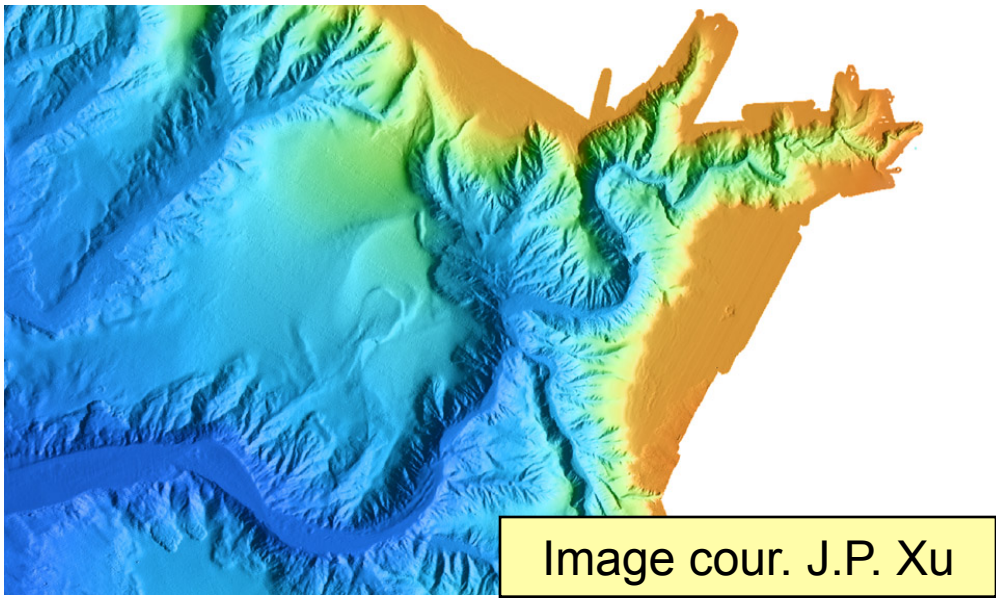


Image cour. J.P. Xu

TURBIDITY CURRENTS & SUBMARINE DEBRIS FLOWS:

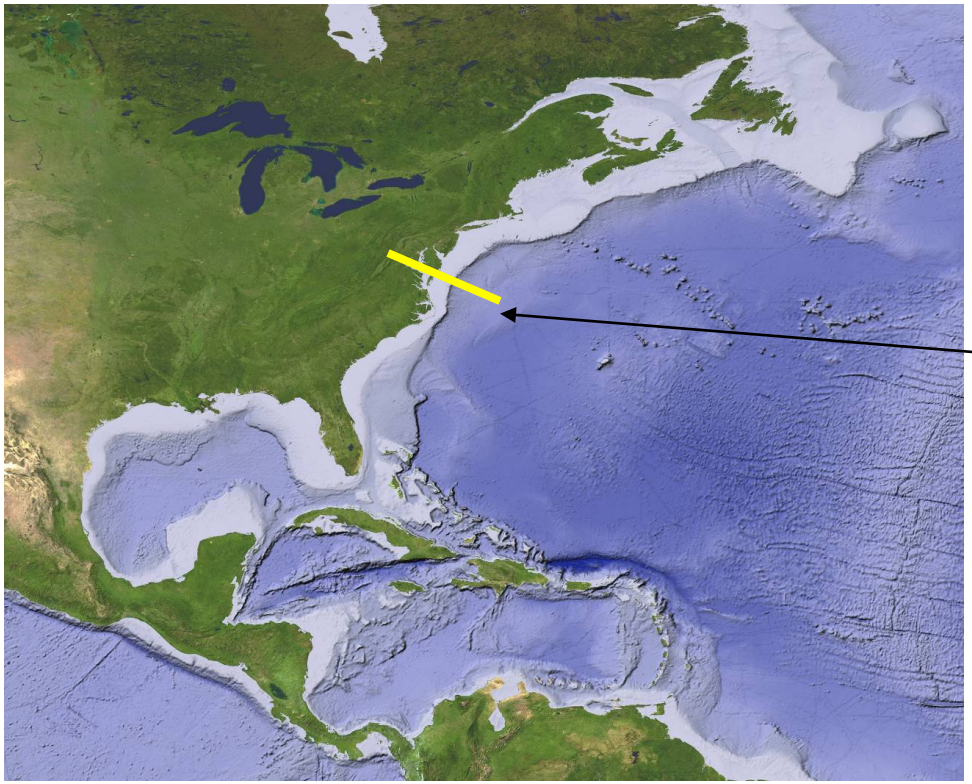
Mechanisms for the Dispersal of Sediment from the Nearshore Zone to Deep Water

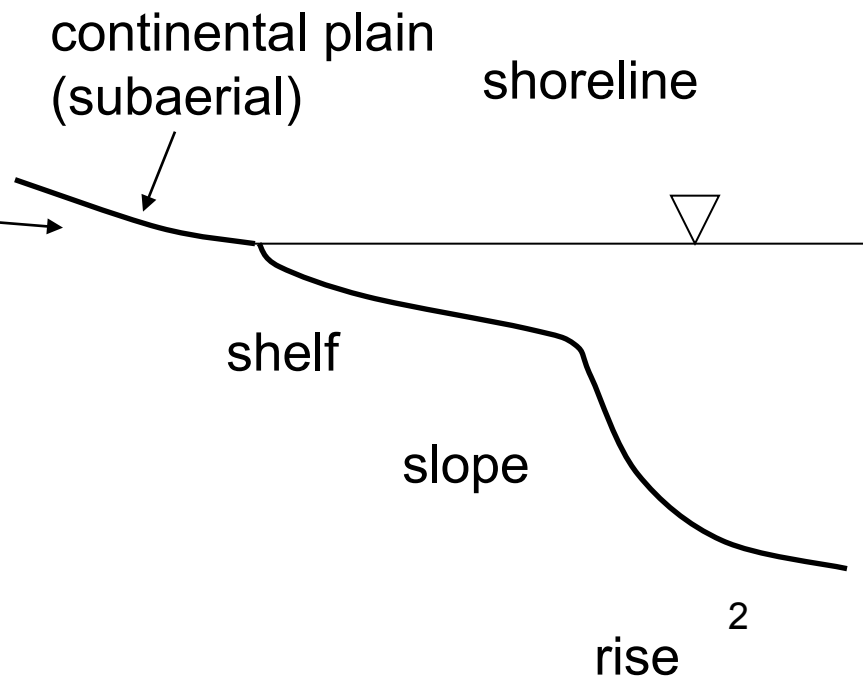
Gary Parker
Dept. of Civil & Environmental Engineering & Dept. of Geology
University of Illinois Urbana-Champaign, USA

EVERY CONTINENT IS SURROUNDED BY A SHELF/SLOPE MARGIN COMPLEX

OK maybe not the Red Sea.

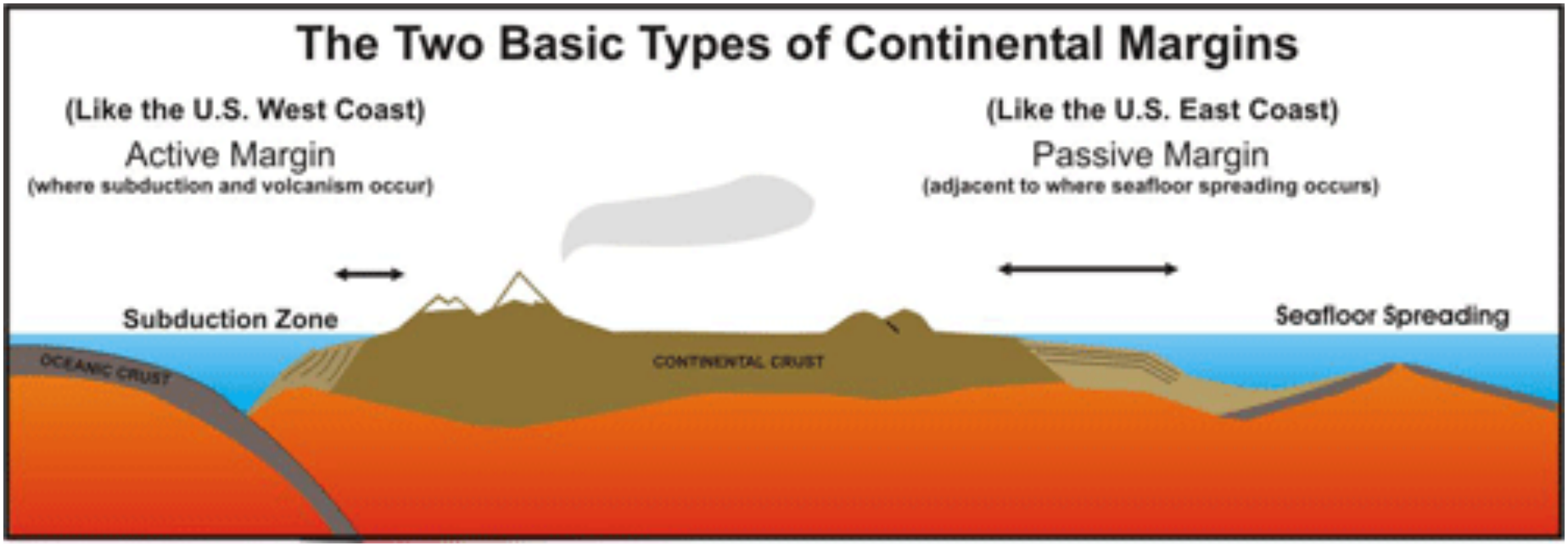
The margin consists of a **shelf** (out to ~ 100 m depth), **slope**, and **rise** (which tapers off into deep water).





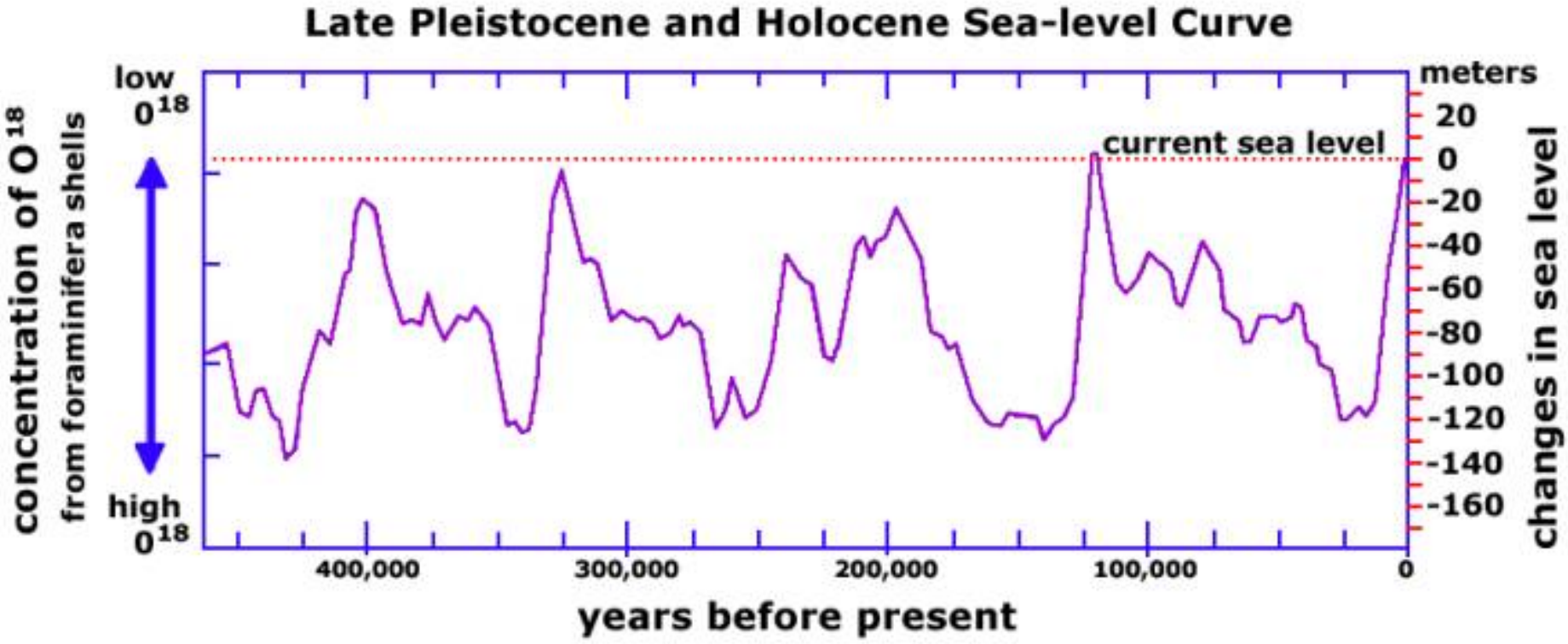
CONTINENTAL MARGINS COME IN TWO BASIC FLAVORS DEPENDING ON THE TECTONIC SETTING: ACTIVE AND PASSIVE MARGINS

Passive margins tend to be broad, with extensive shelves.
Active margins tend to be narrow, with constricted shelves.



N. Driscoll and others: http://sio.ucsd.edu/png/science/

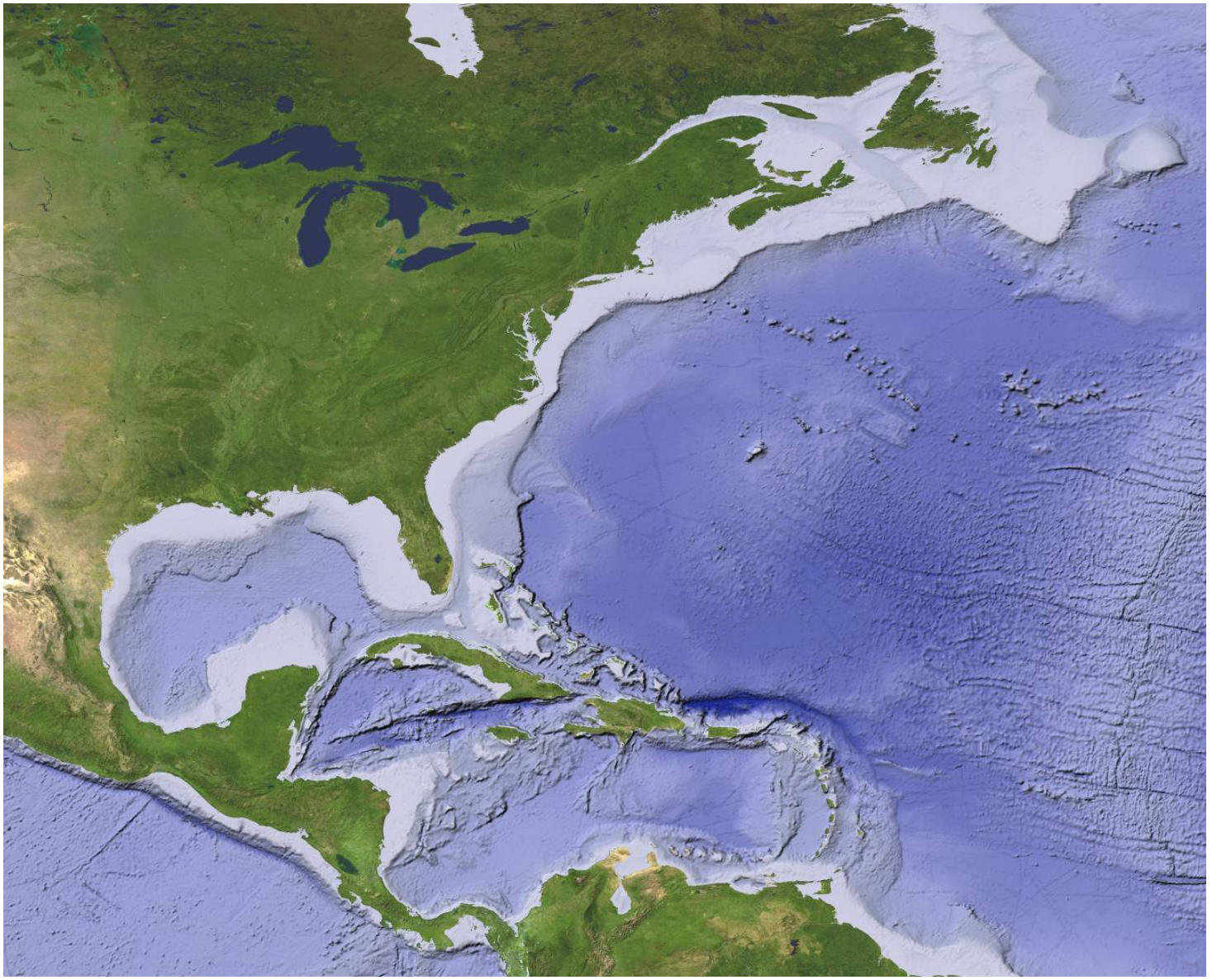
INTERGLACIAL HIGH STAND TENDS TO SHUT DOWN THE DISPERSAL PROCESS ON PASSIVE MARGINS



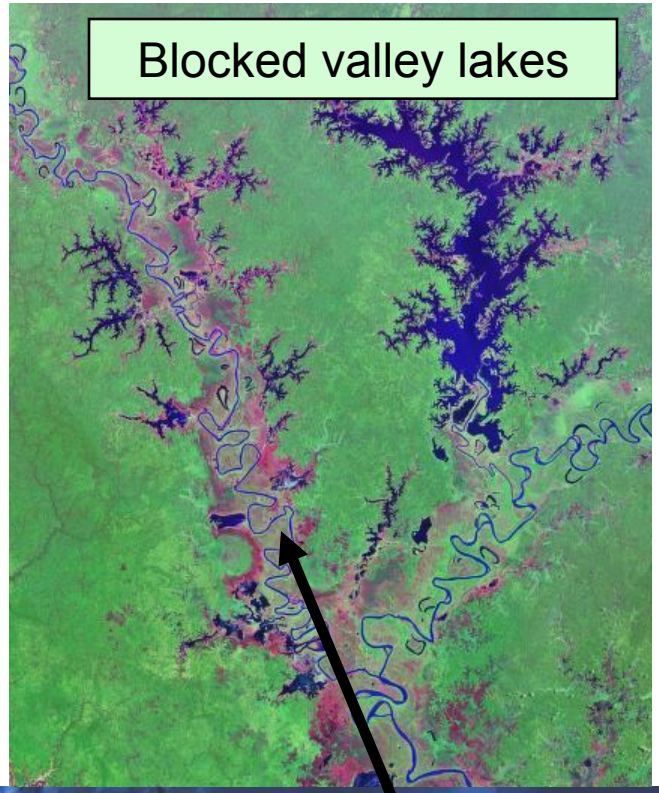
Source of data modified from CLIMAP isotopic data summarized in chart is from *Ice Ages* by John Imbrie and Katherine Imbrie, 1979

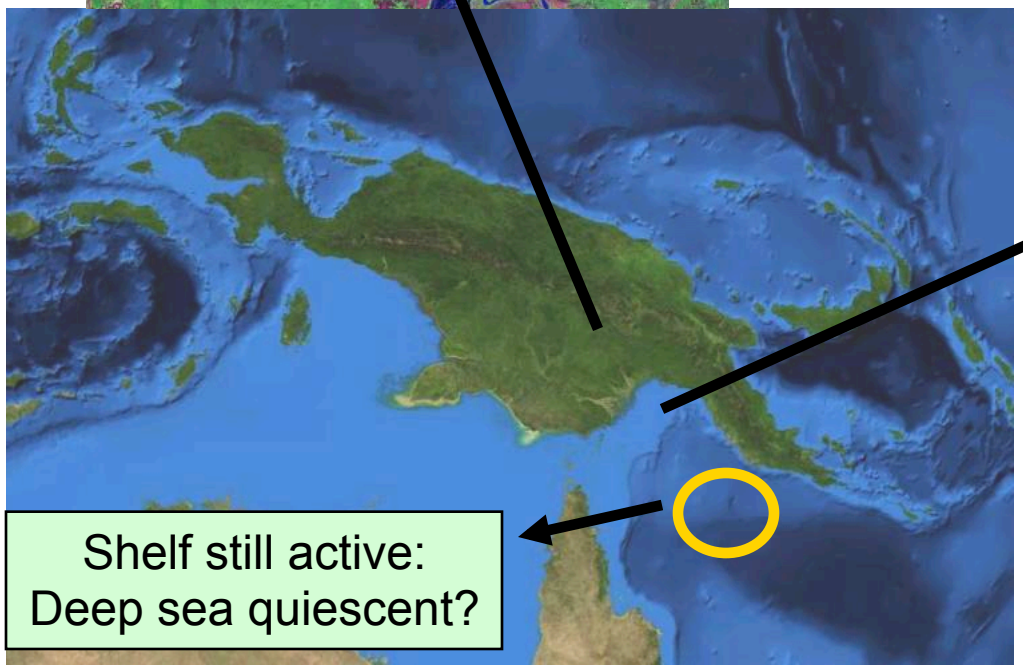
http://www.teachingboxes.org/seaLevel/lessons/lesson4_SeaLevelCurveGraph.htm

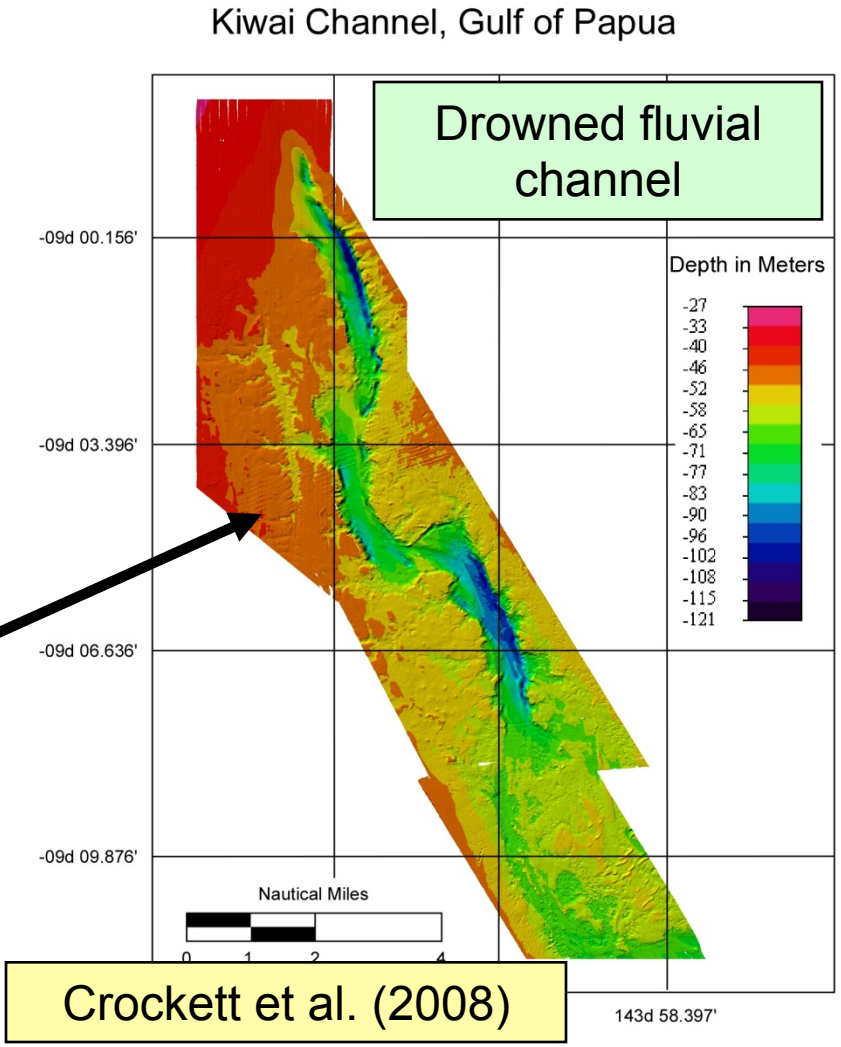
THE CONTINENTAL MARGIN OF THE EAST COAST OF NORTH AMERICA IS SHUT DOWN AT PRESENT



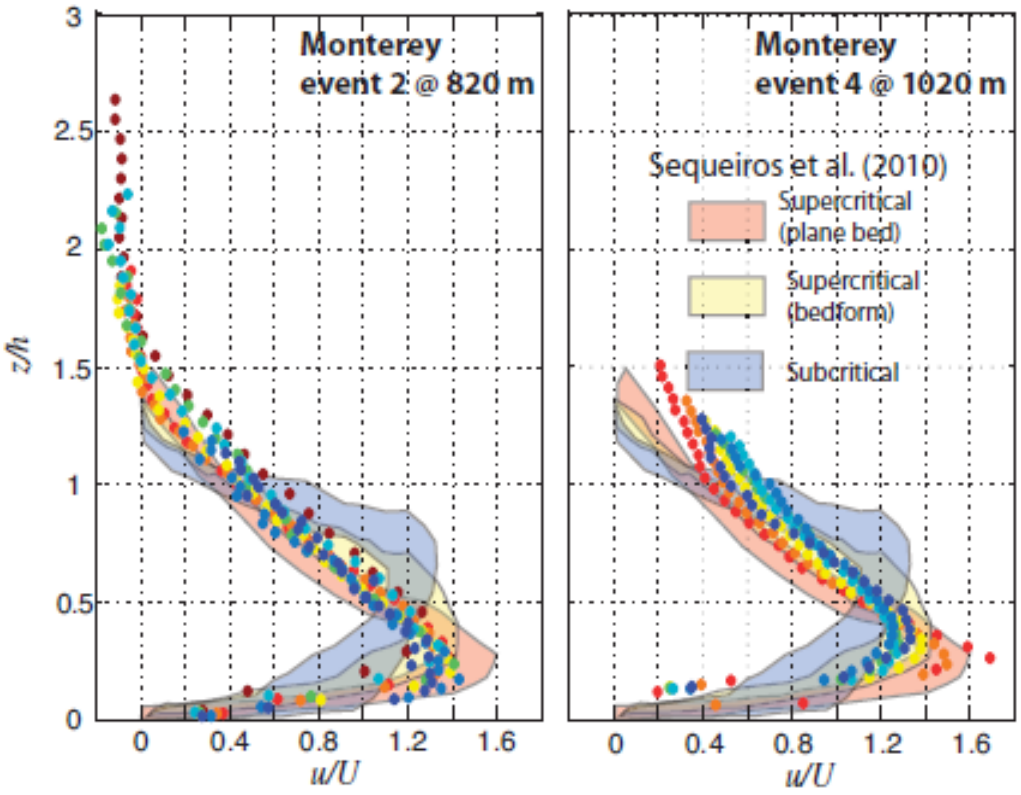
SEA LEVEL RISE/HIGH STAND IN THE SOURCE TO SINK CONTEXT

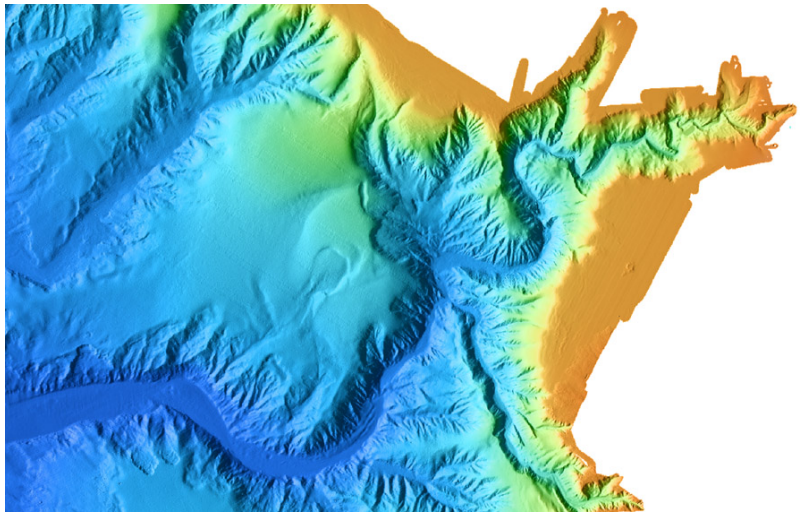


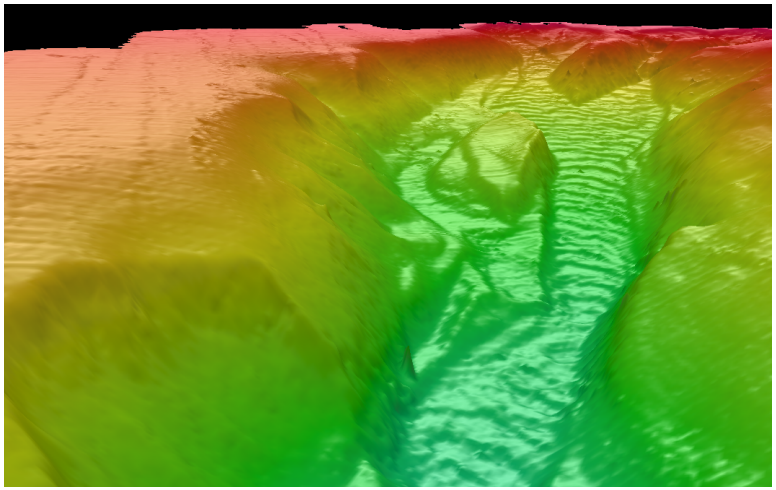




THE ACTIVE MARGIN OF THE CALIFORNIA COAST REMAINS ACTIVE TODAY



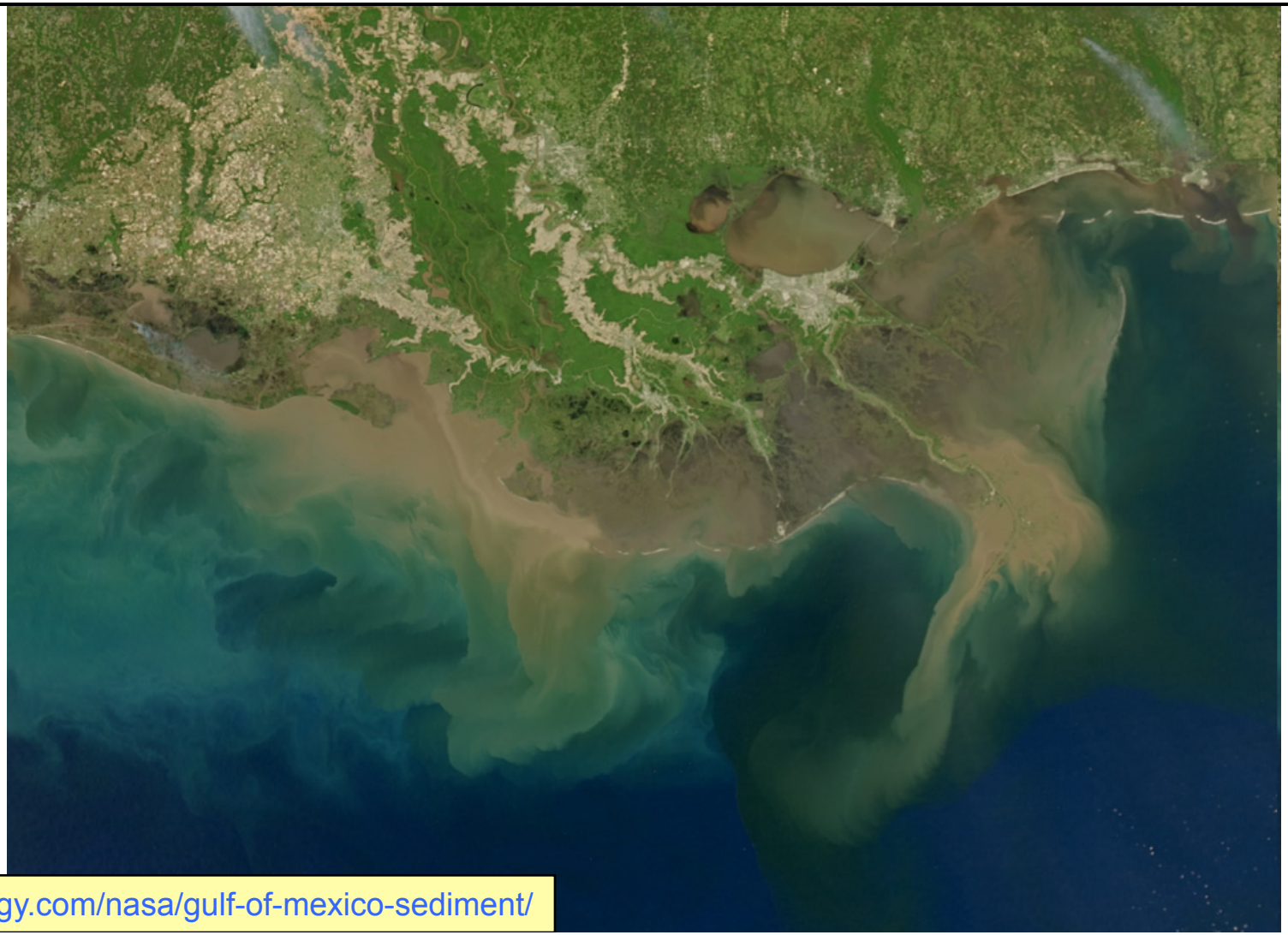




Xu et al. 2008
Xu, 2010
Sequeiros et al. 2010

THREE MAJOR MECHANISMS OF SEDIMENT DELIVERY FROM THE CONTINENTAL SHELF TO DEEP WATER

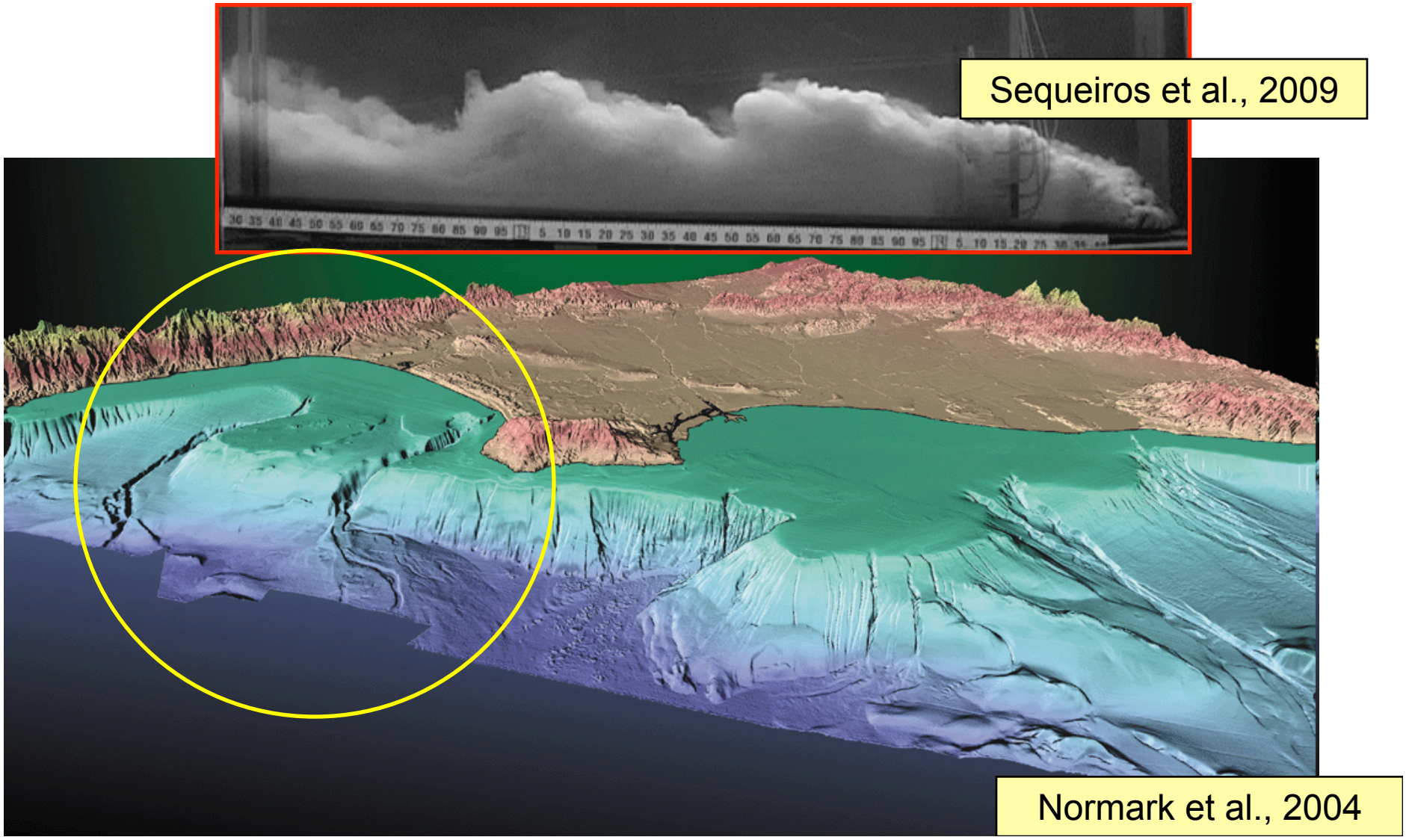
Hemipelagic sedimentation: Mississippi Delta



http://geology.com/nasa/gulf-of-mexico-sediment/

THREE MAJOR MECHANISMS OF SEDIMENT DELIVERY FROM THE CONTINENTAL SHELF TO DEEP WATER

Turbidity Currents: laboratory and Southern California

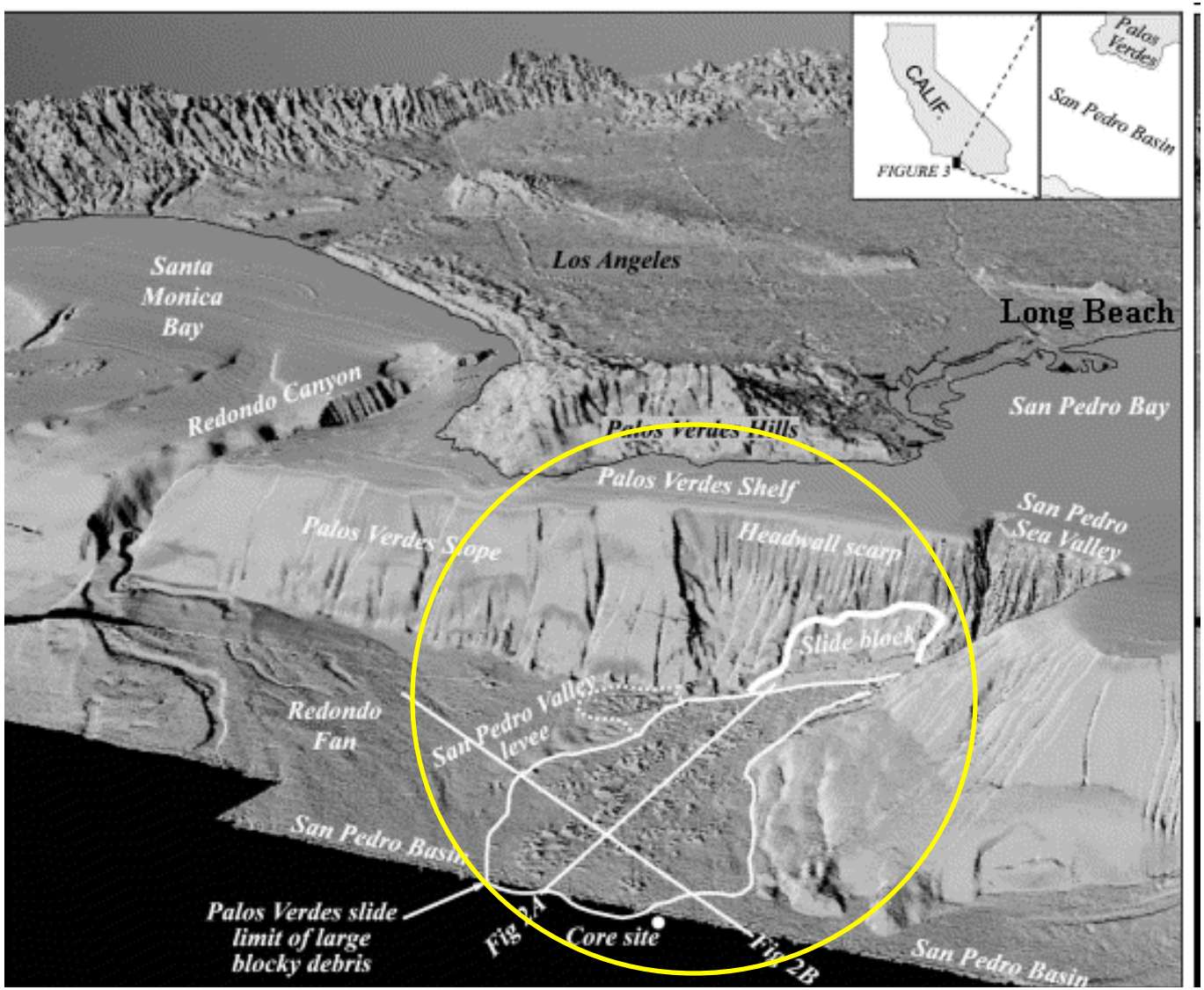


Sequeiros et al., 2009

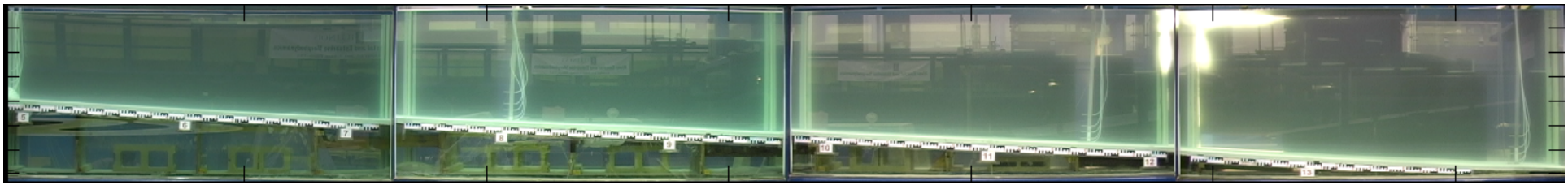
Normark et al., 2004

THREE MAJOR MECHANISMS OF SEDIMENT DELIVERY FROM THE CONTINENTAL SHELF TO DEEP WATER

Submarine landslides/debris flows: Southern California



LABORATORY TURBIDITY CURRENT



LABORATORY SUBMARINE DEBRIS FLOW

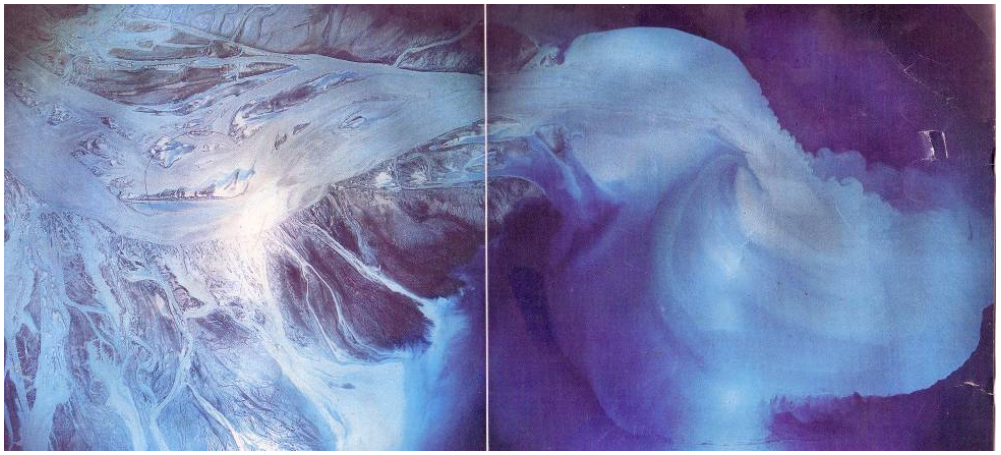
GENERATION OF TURBIDITY CURRENTS AND SUBMARINE DEBRIS FLOWS

- Wave-supported sheet-like turbidity currents
- Canyon-focused storms
- Delta/margin failure due to overpressuring
- Seismicity
- Hyperpycnal flows
- Breaching

GENERATION OF TURBIDITY CURRENTS: HYPERPYCNAL FLOWS

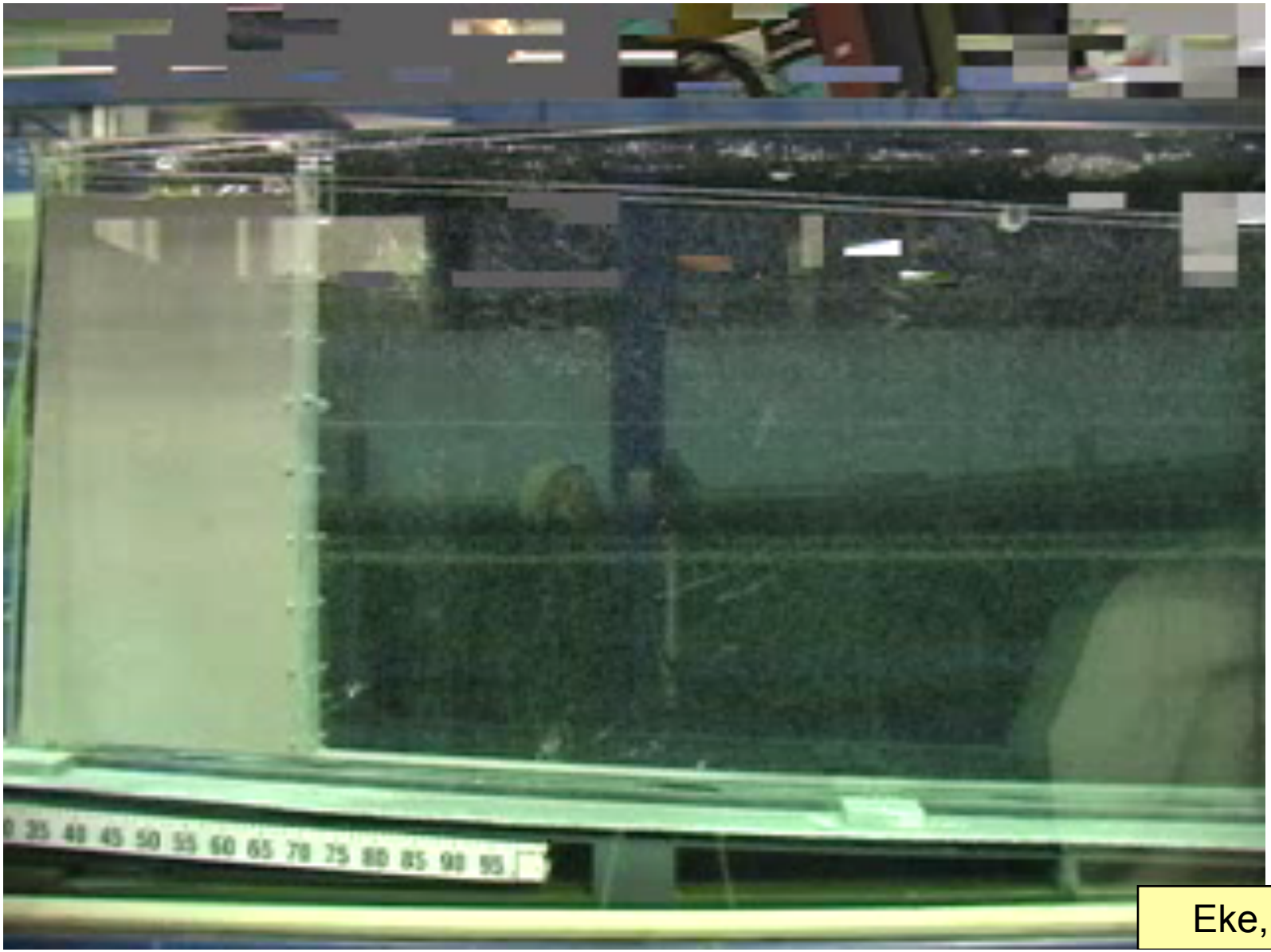
Reuss River, Switzerland

Eel River Margin, California



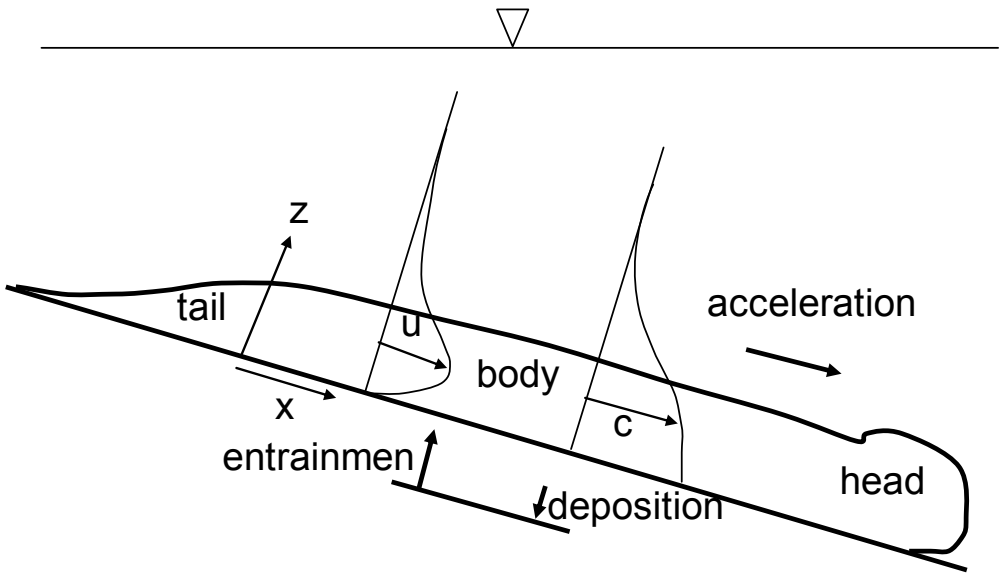
Yellow River, China

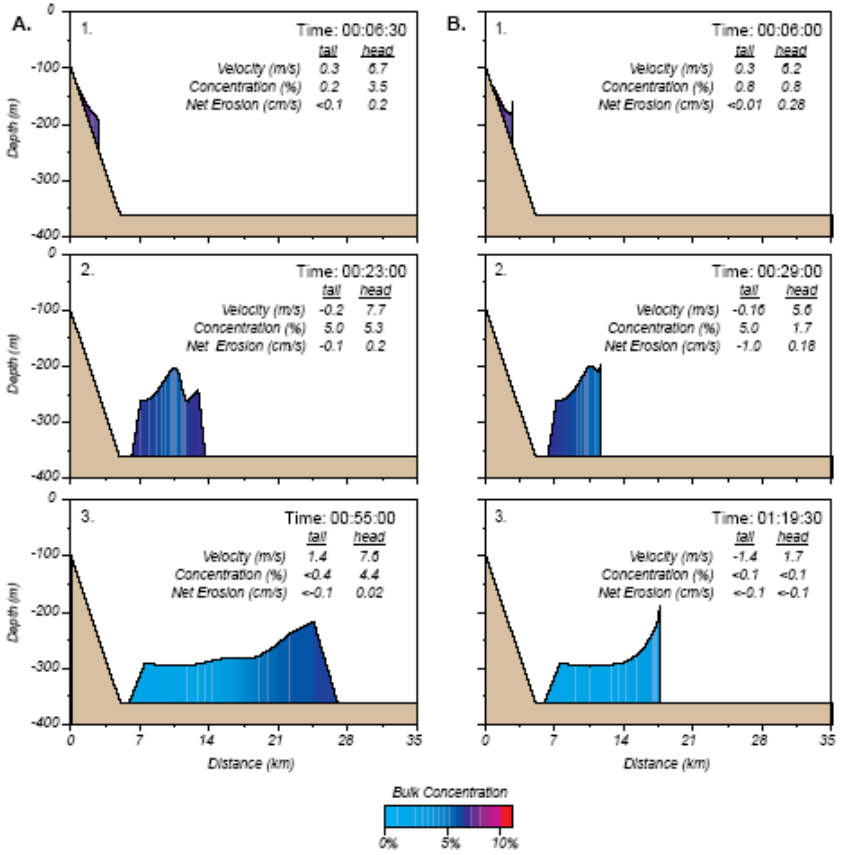
GENERATION OF TURBIDITY CURRENTS: BREACHING



Eke, 2008

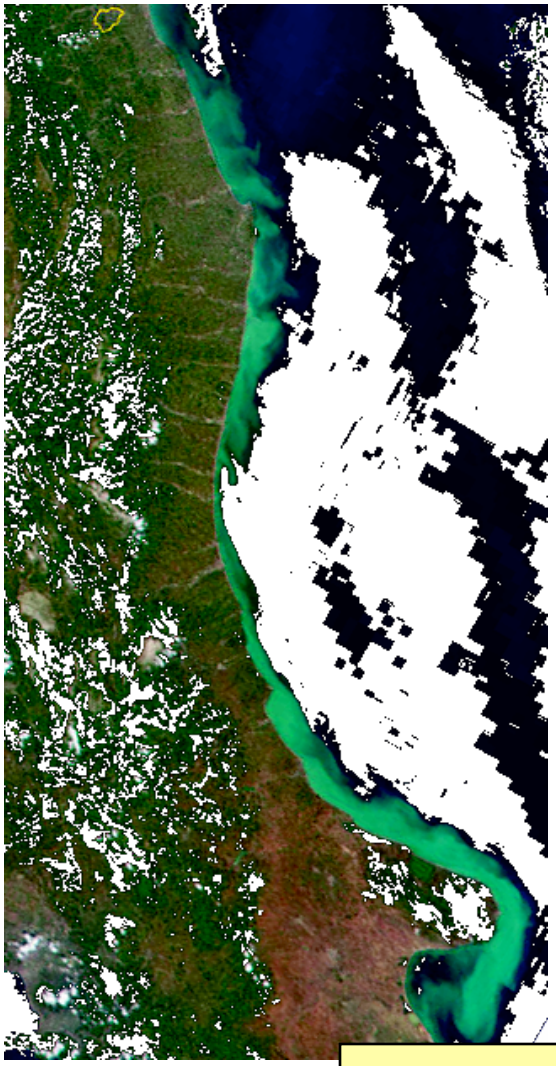
A TURBIDITY CURRENT CAN START OUT SMALL AND GET BIG BY THE PROCESS OF IGNITION (SELF-ACCELERATION)

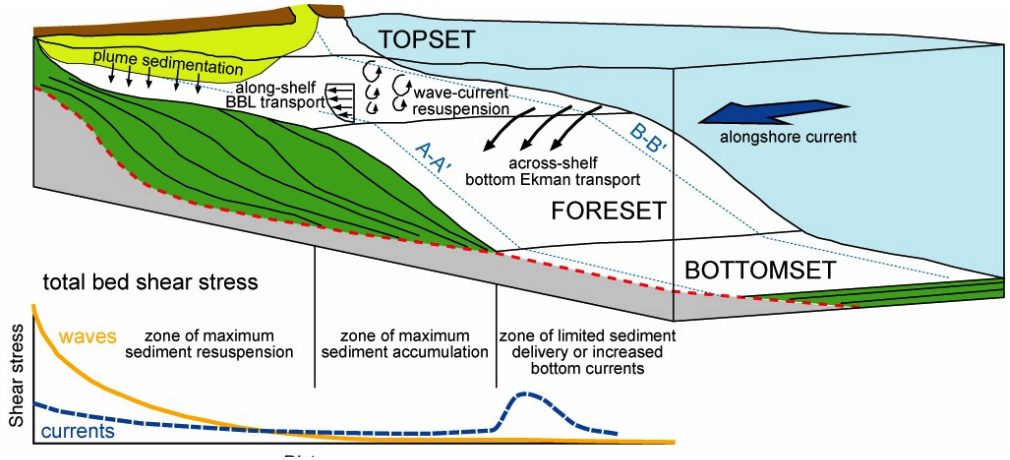




Current entrains bed sediment, gets heavier, is pulled downslope more strongly by gravity, accelerates, entrains more sediment in a self-reinforcing cycle (Parker Fukushima and Pantin, 1986; Pratson, Imran, Parker, Syvitski, Hutton, 2000)

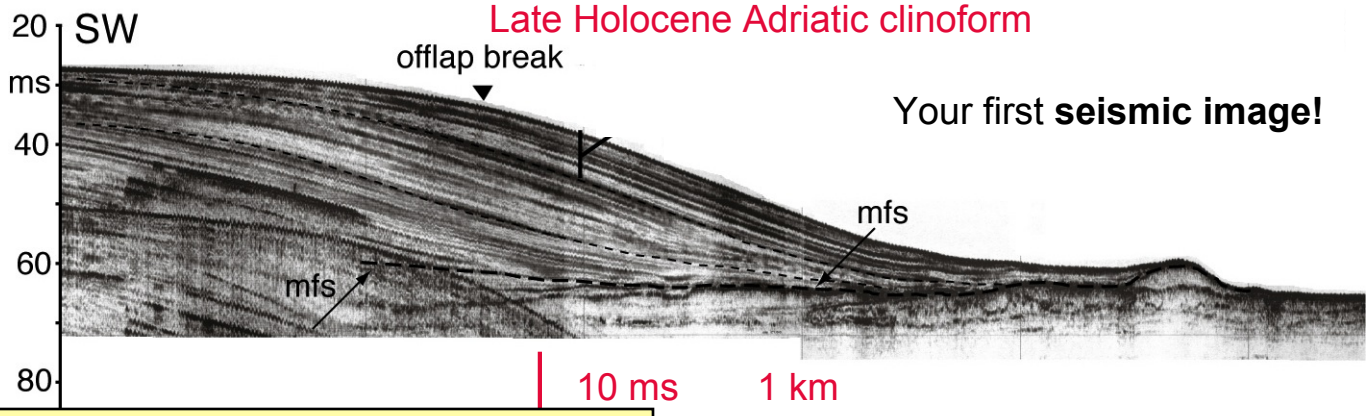
PATHWAYS AND MORPHOLOGIES: WAVE-SUPPORTED SHEET TURBIDITY CURRENTS AND CLINOFORMS ON CONTINENTAL SLOPES





Wave resuspension

Diluted muddy turbidity currents

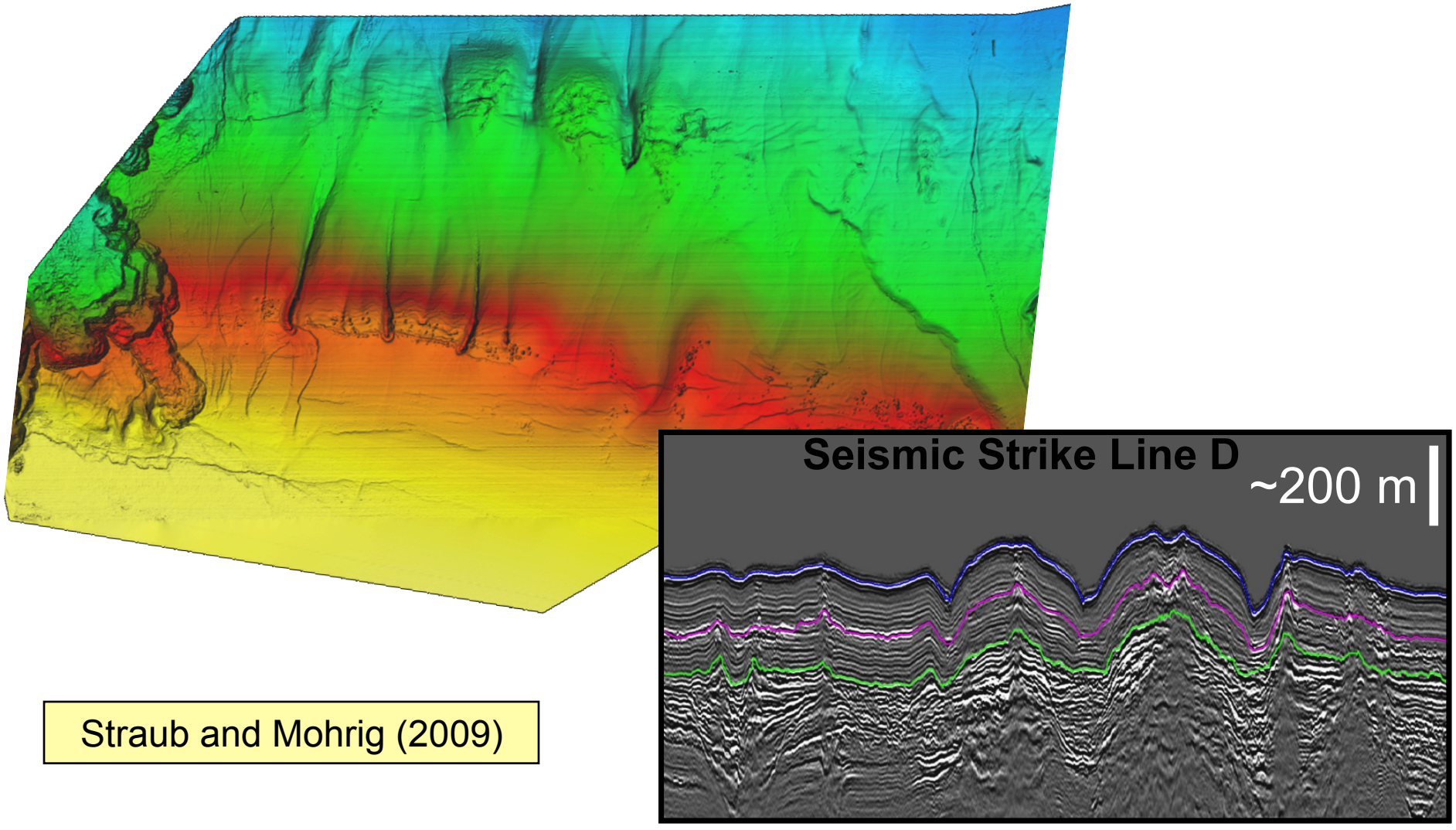


Late Holocene Adriatic clinoform

Your first **seismic image!**

Adriatic margin: cour. F. Trincardi

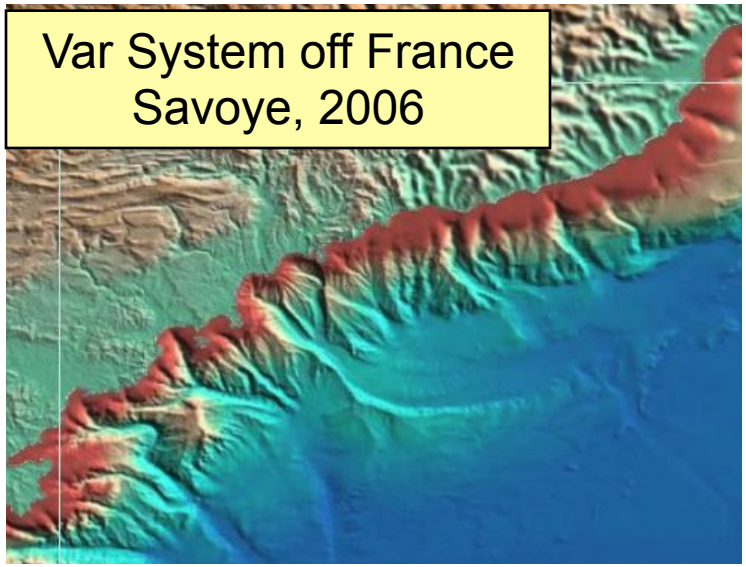
PATHWAYS AND MORPHOLOGIES: SHEET TURBIDITY CURRENTS AND CONSTRUCTIONAL CANYONS ON CONTINENTAL SLOPES



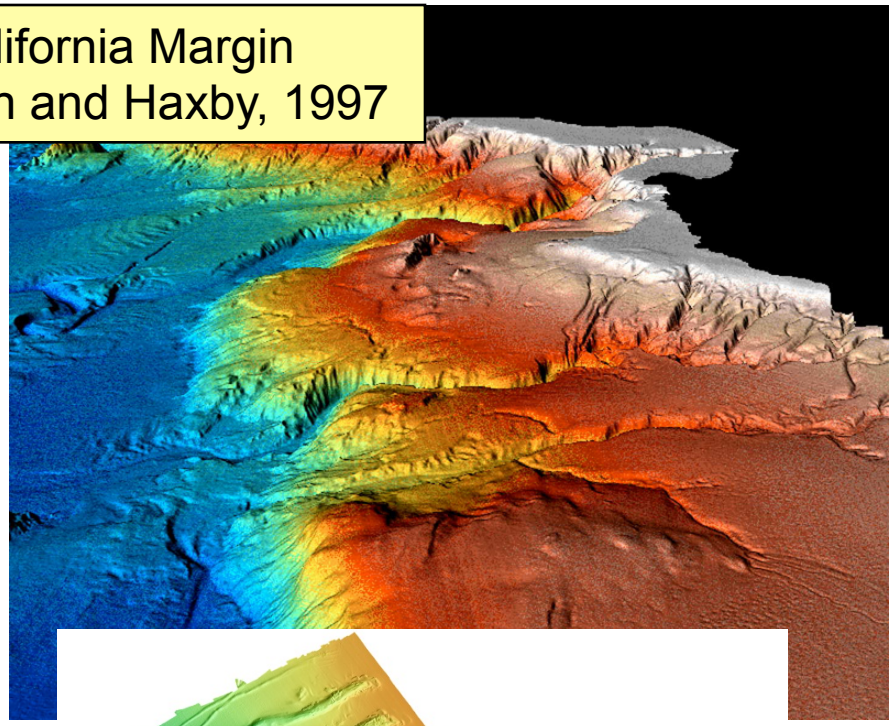
Straub and Mohrig (2009)

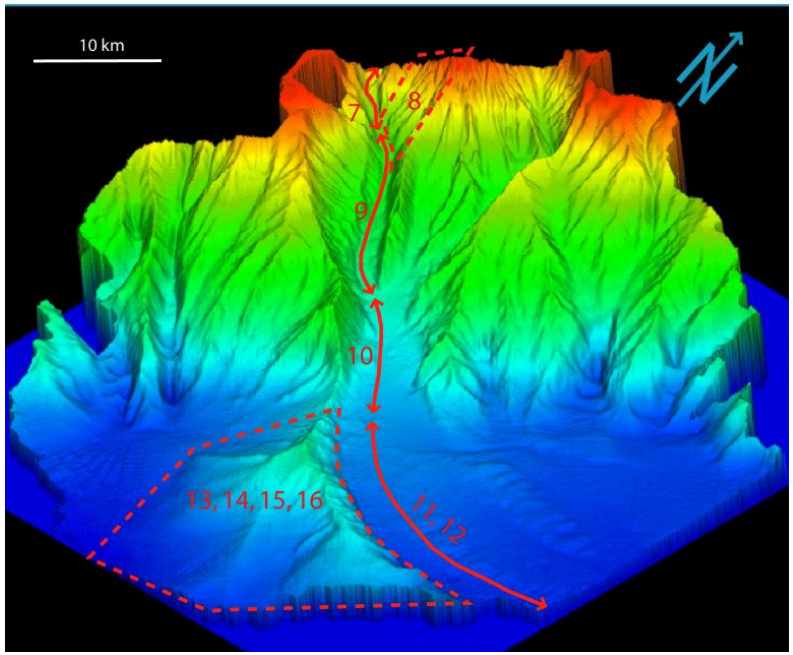
PATHWAYS AND MORPHOLOGIES: SUBMARINE CANYONS

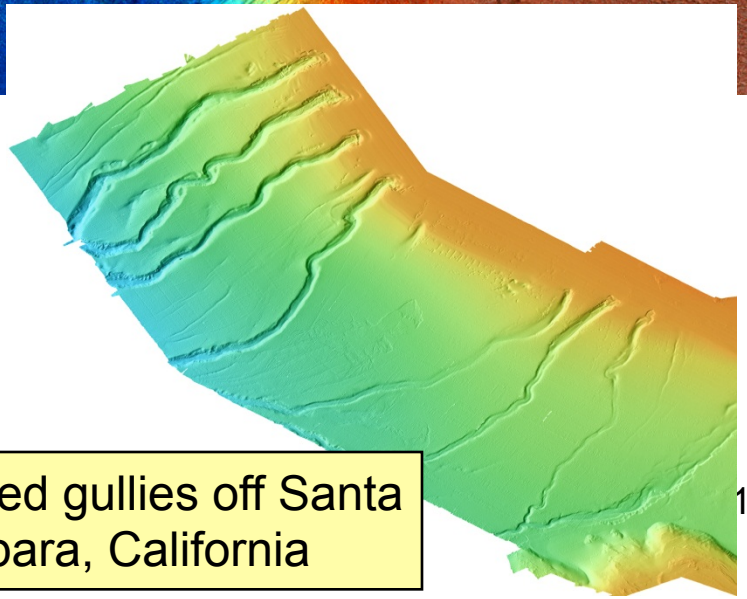
Var System off France
Savoye, 2006



California Margin
Pratson and Haxby, 1997

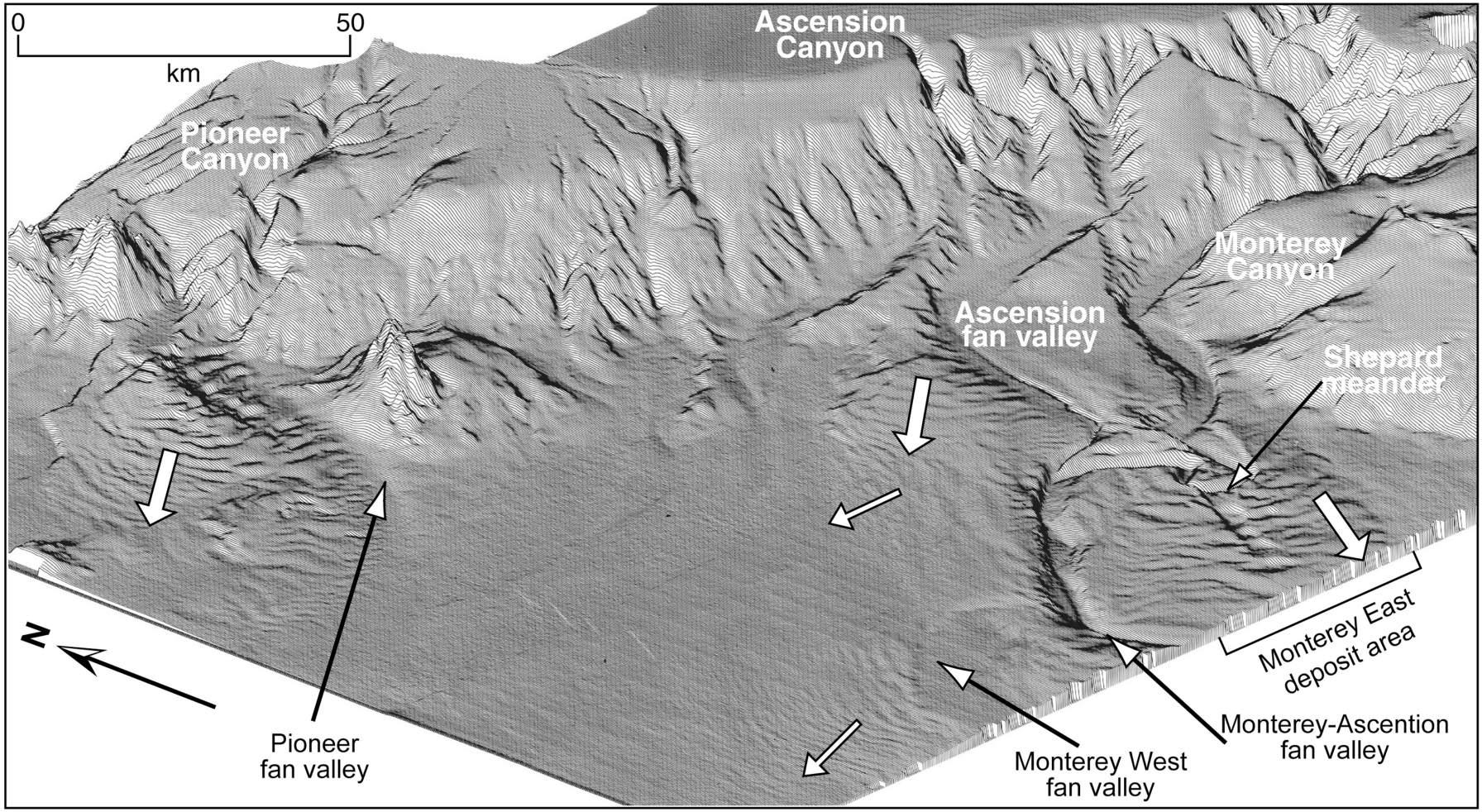






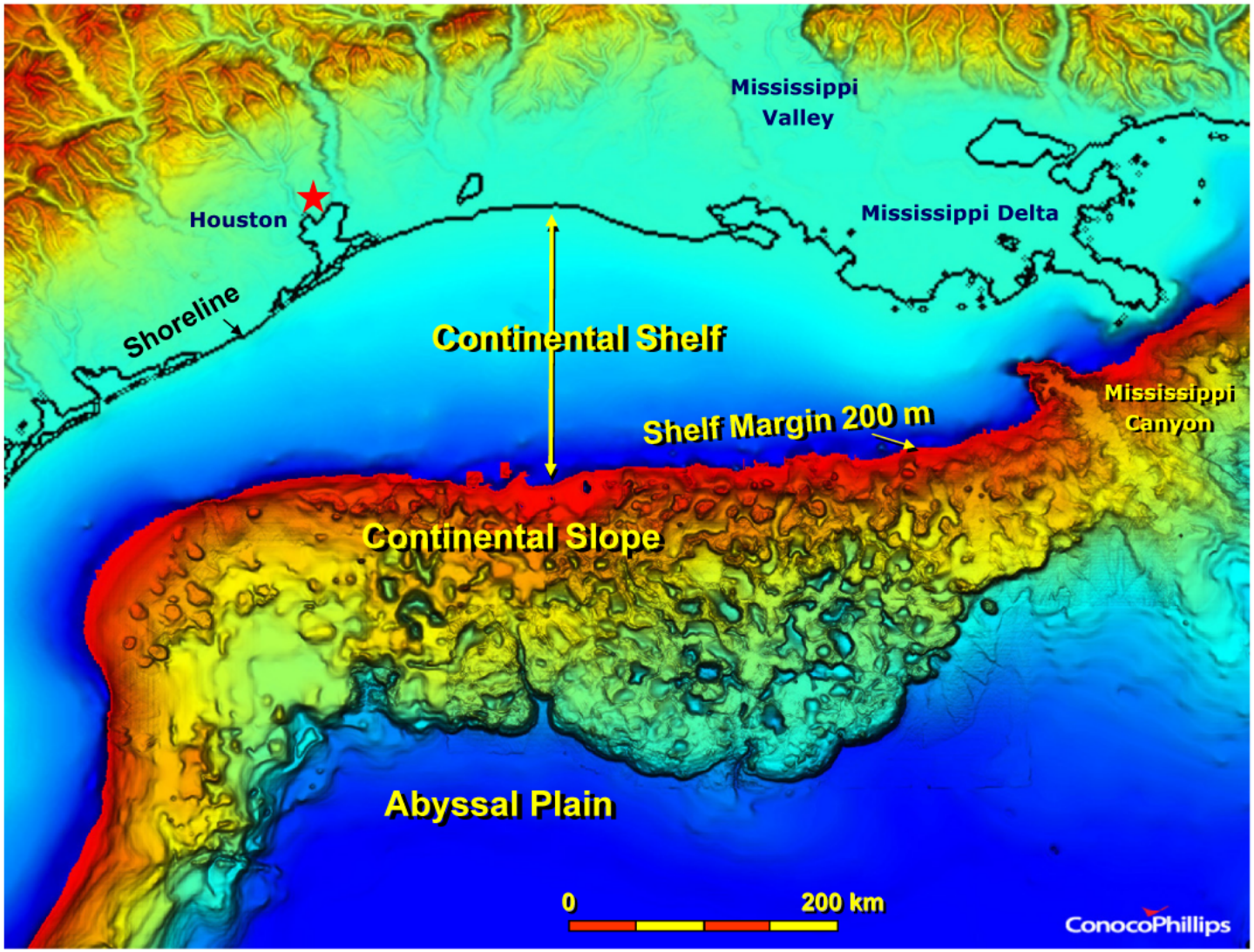
Unsourced gullies off Santa Barbara, California

PATHWAYS AND MORPHOLOGIES: SPILLOVER AT SLOPE-RISE BREAKS

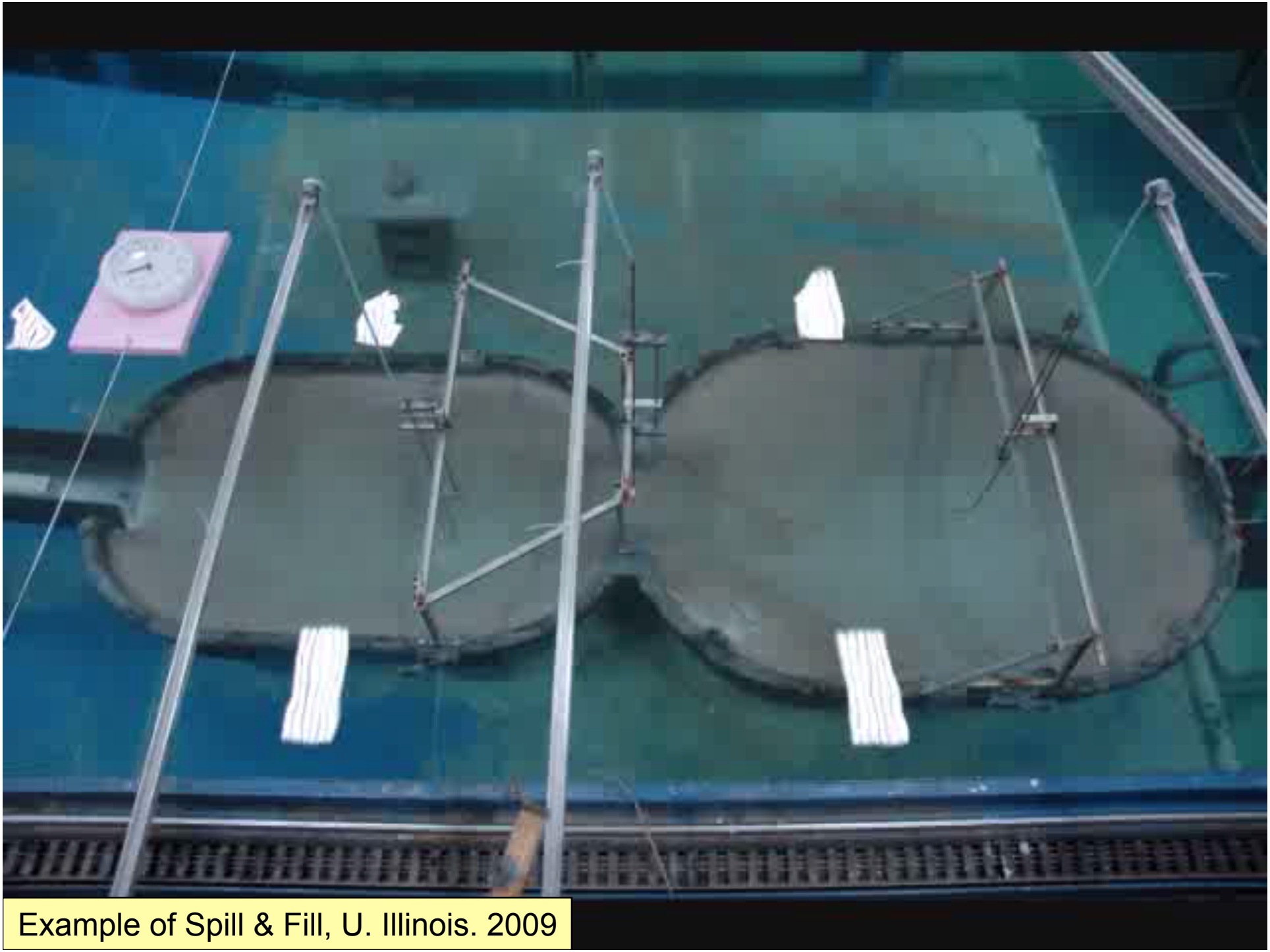


Normark et al. 2002

PATHWAYS AND MORPHOLOGIES: MINIBASIN SPILL AND FILL

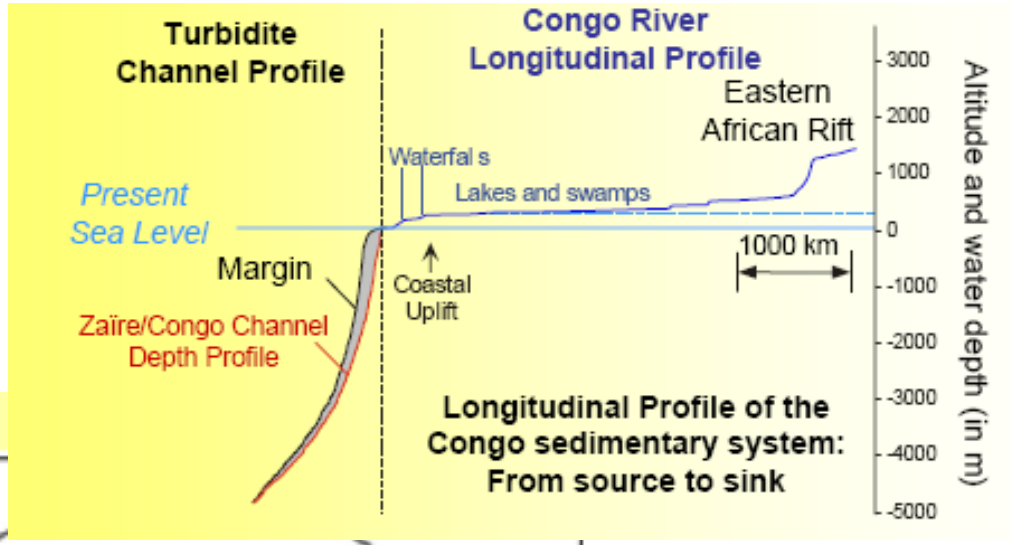


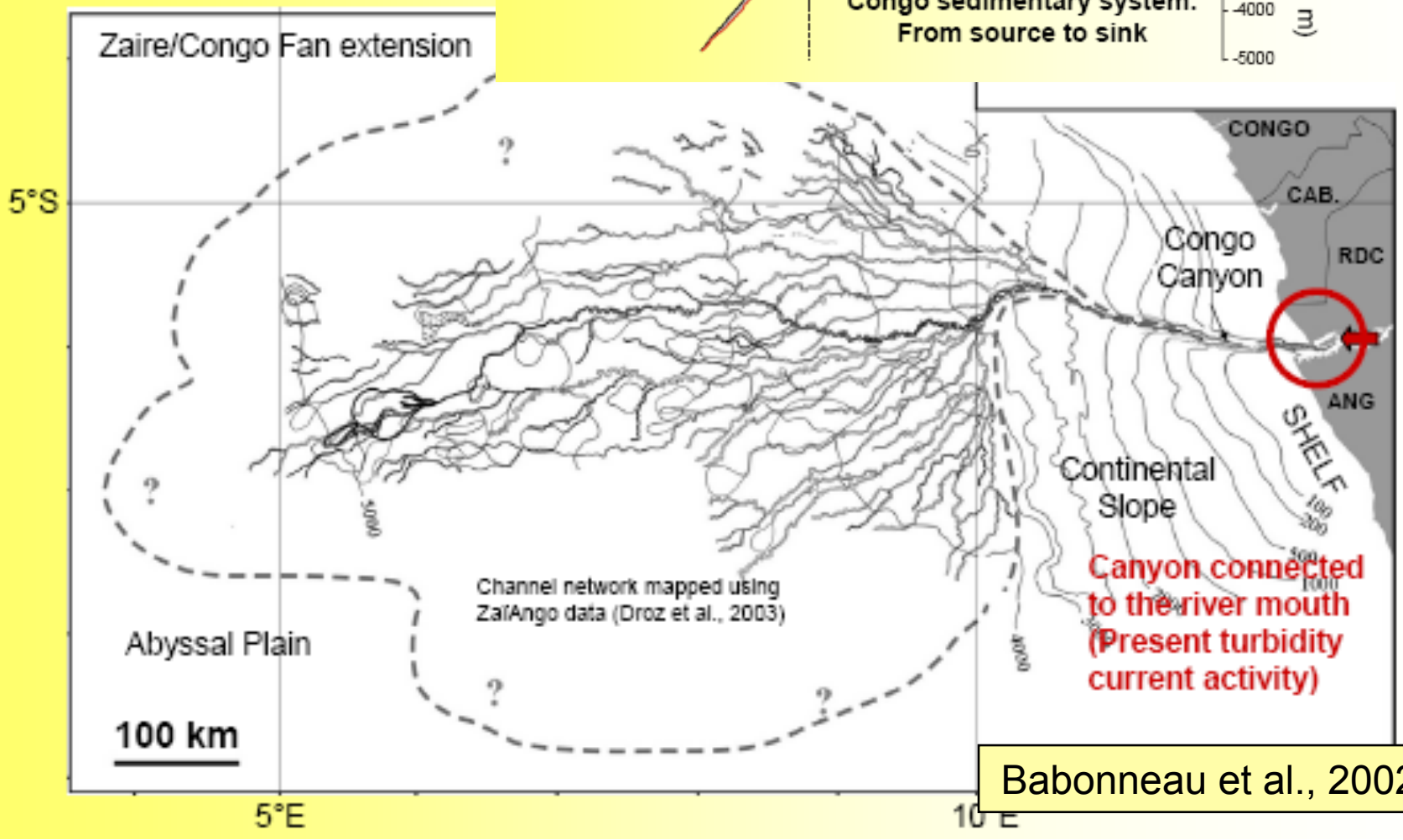
Suter, J. R., 2006



Example of Spill & Fill, U. Illinois. 2009

PATHWAYS AND MORPHOLOGIES: SUBMARINE FANS





Babonneau et al., 2002

PATHWAYS AND MORPHOLOGIES: STRUCTURE OF SUBMARINE FANS

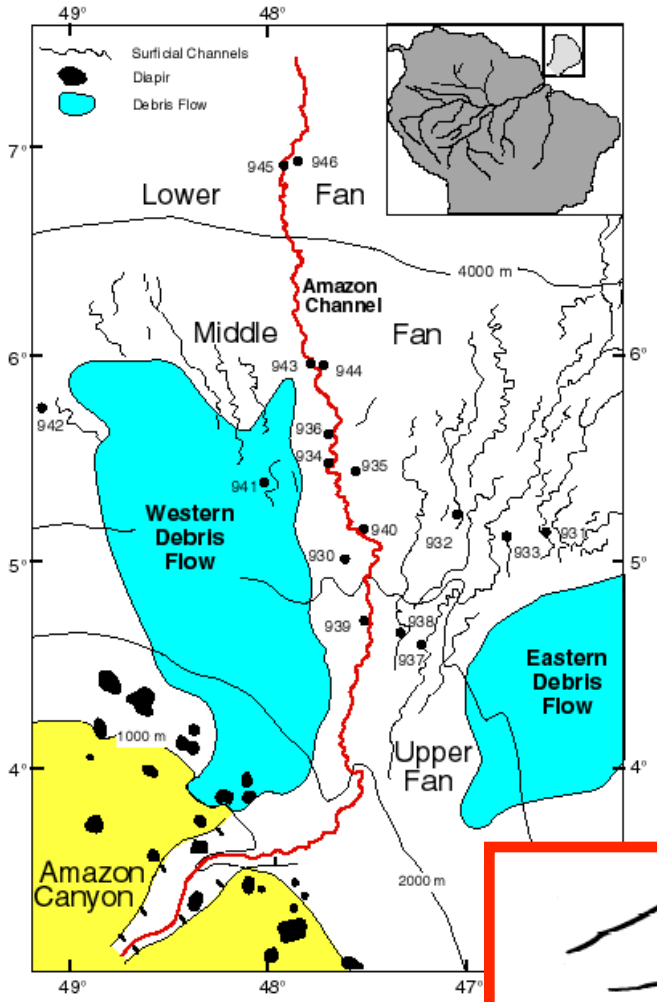


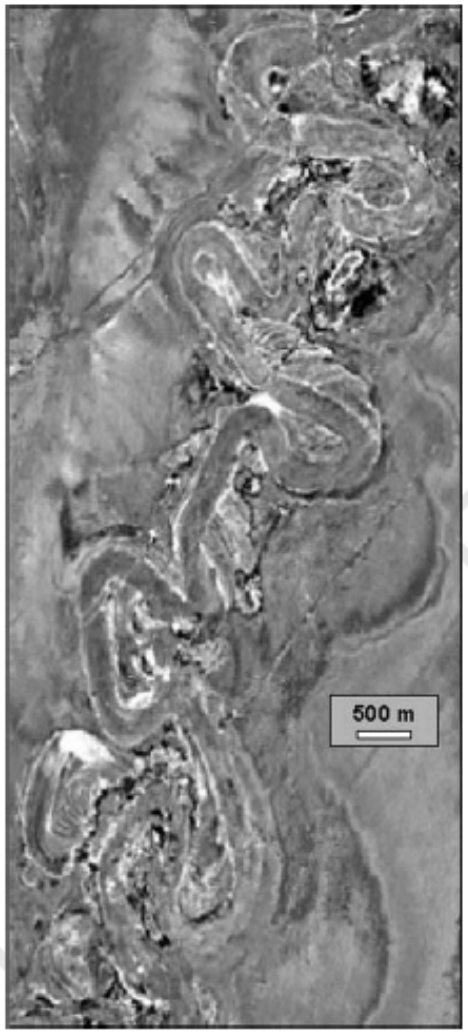
Figure 1. Surface features of Amazon Fan. Thick (red) recently active channel system, Amazon Channe

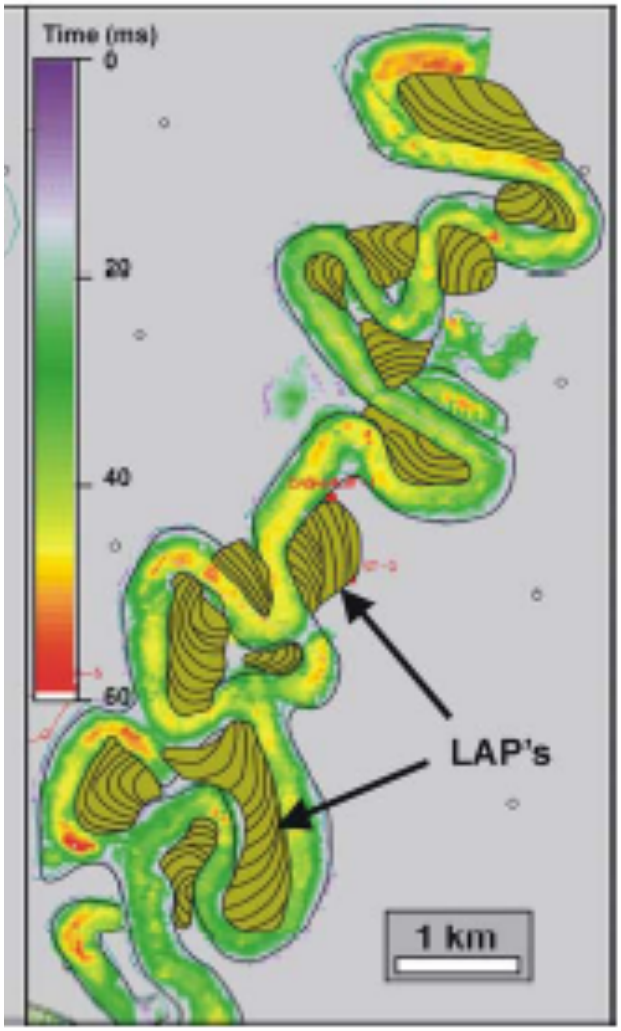
Pirmez, 1995

Flood et al., 1991

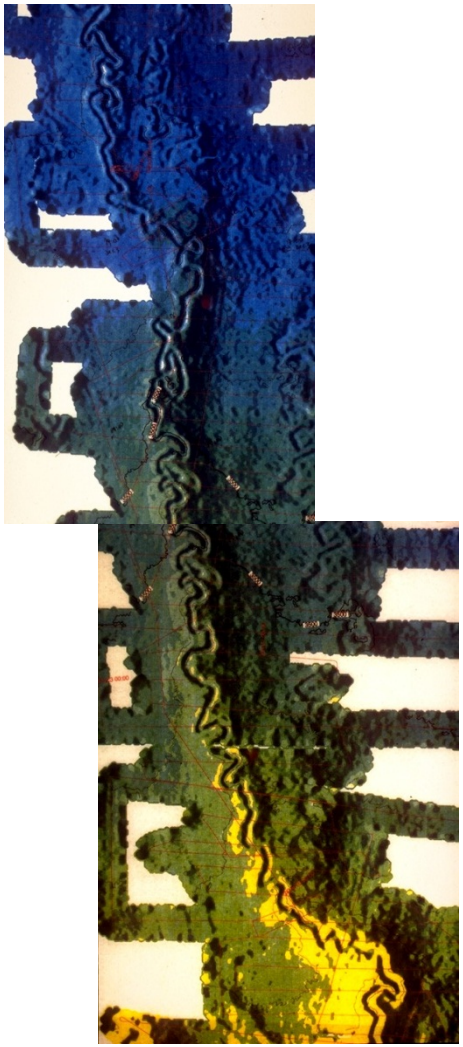
km

PATHWAYS AND MORPHOLOGIES: MEANDERING CHANNELS ON SUBMARINE FANS





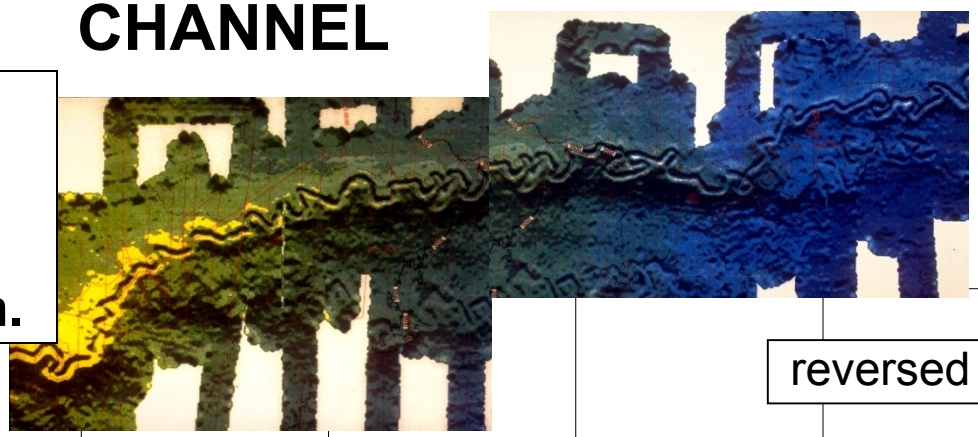
Abreu, Sullivan, Pirmez, Mohrig (2006)

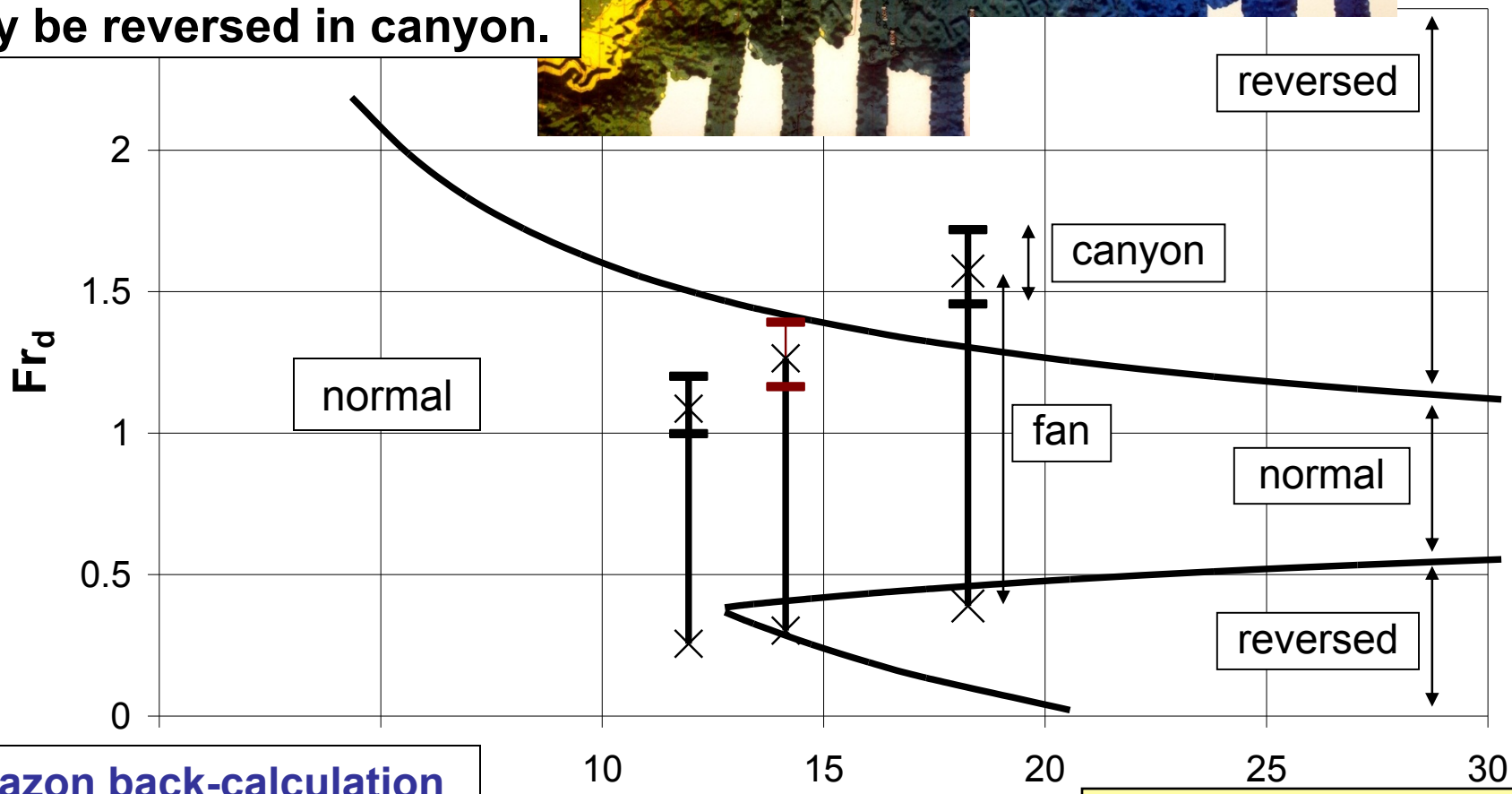


Amazon Submarine Fan: Pirmez (1995)

DIRECTION OF SECONDARY FLOW IN AMAZON SUBMARINE CHANNEL

Normally-directed secondary flow prevails nearly everywhere on fan: may be reversed in canyon.



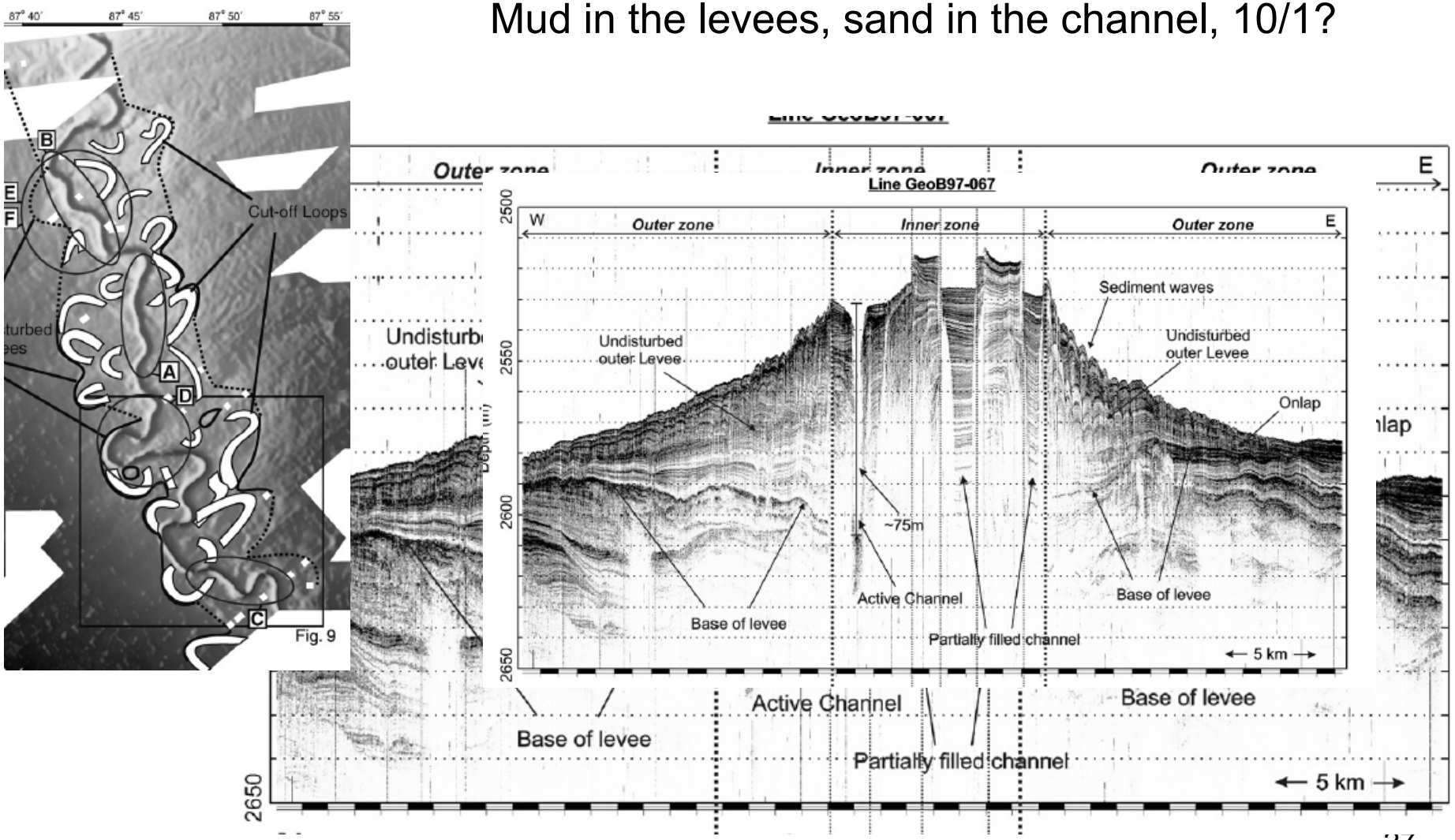


Amazon back-calculation of Pirmez & Imran (2002)
C_f = 0.003, 0.005, 0.007

Abad et al. (accepted subj. to revision)

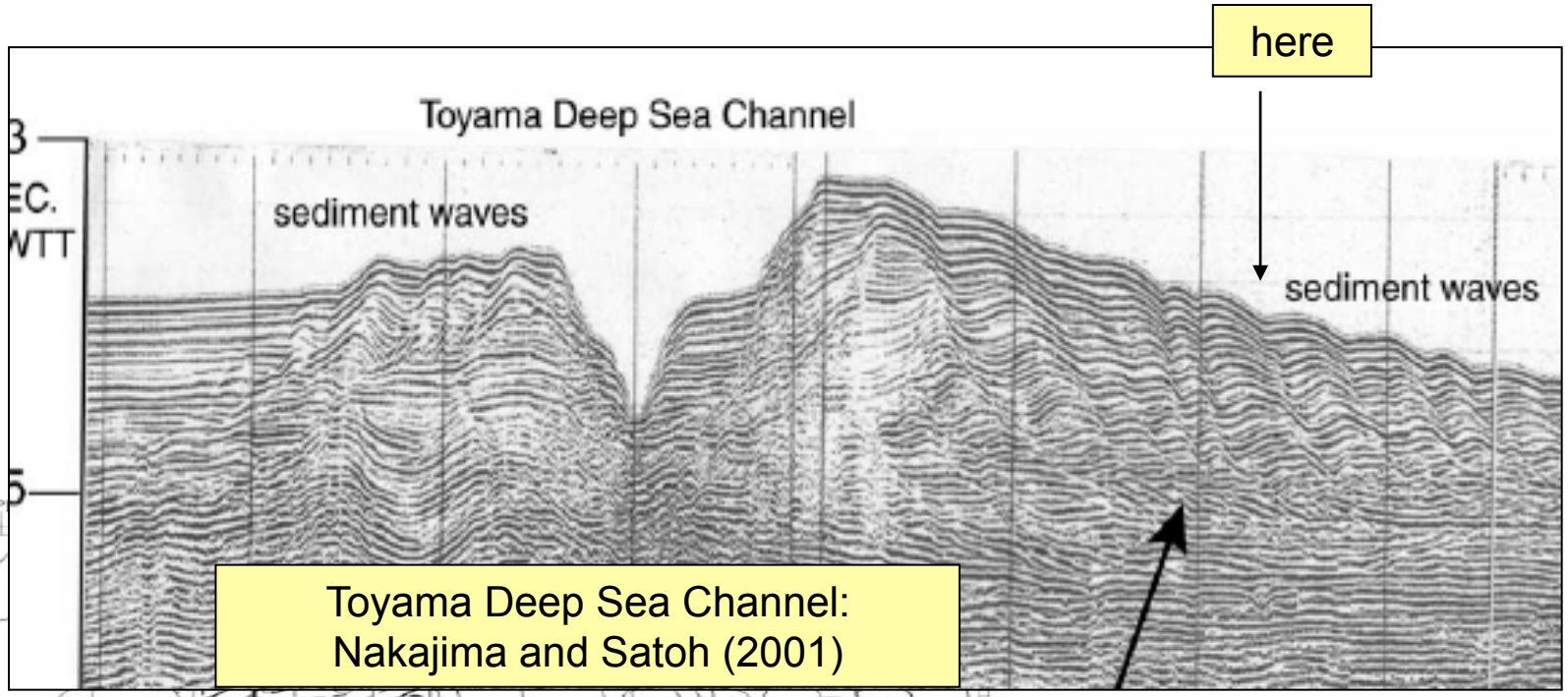
PATHWAYS AND MORPHOLOGIES: LEVEE CONSTRUCTION

Mud in the levees, sand in the channel, 10/1?

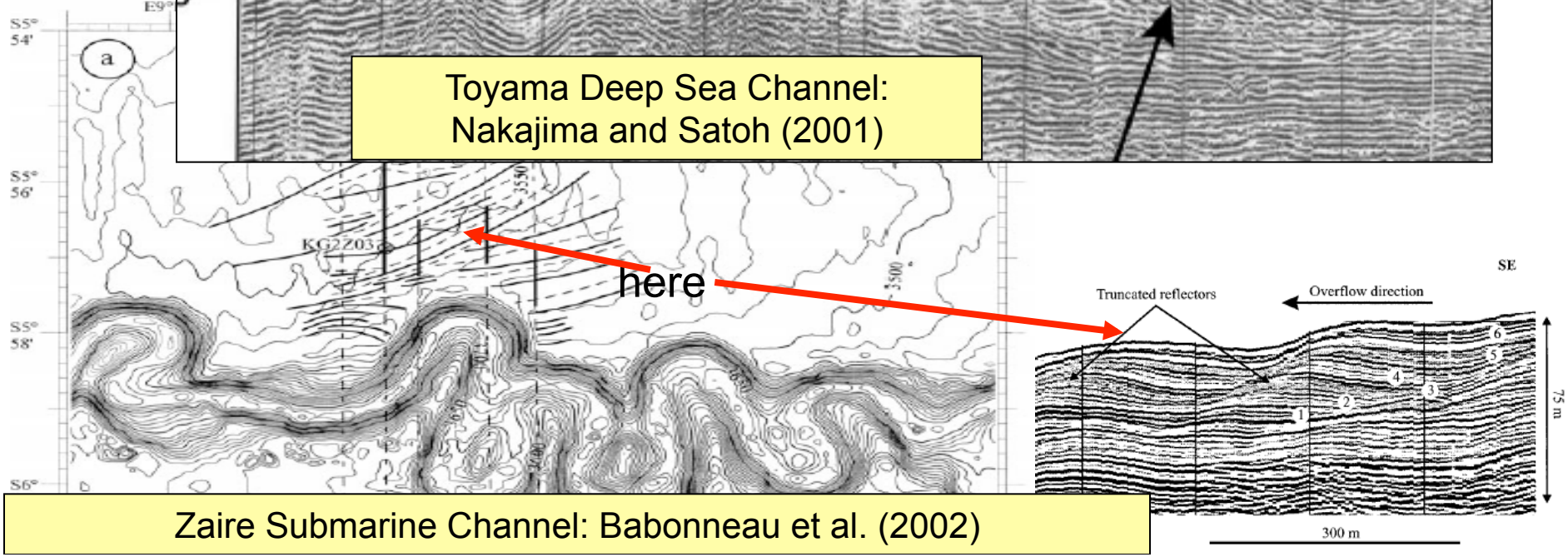


Bengal Fan: Schwenk et al. (2003)

PATHWAYS AND MORPHOLOGIES: SEDIMENT WAVES ON LEVEED CHANNELS

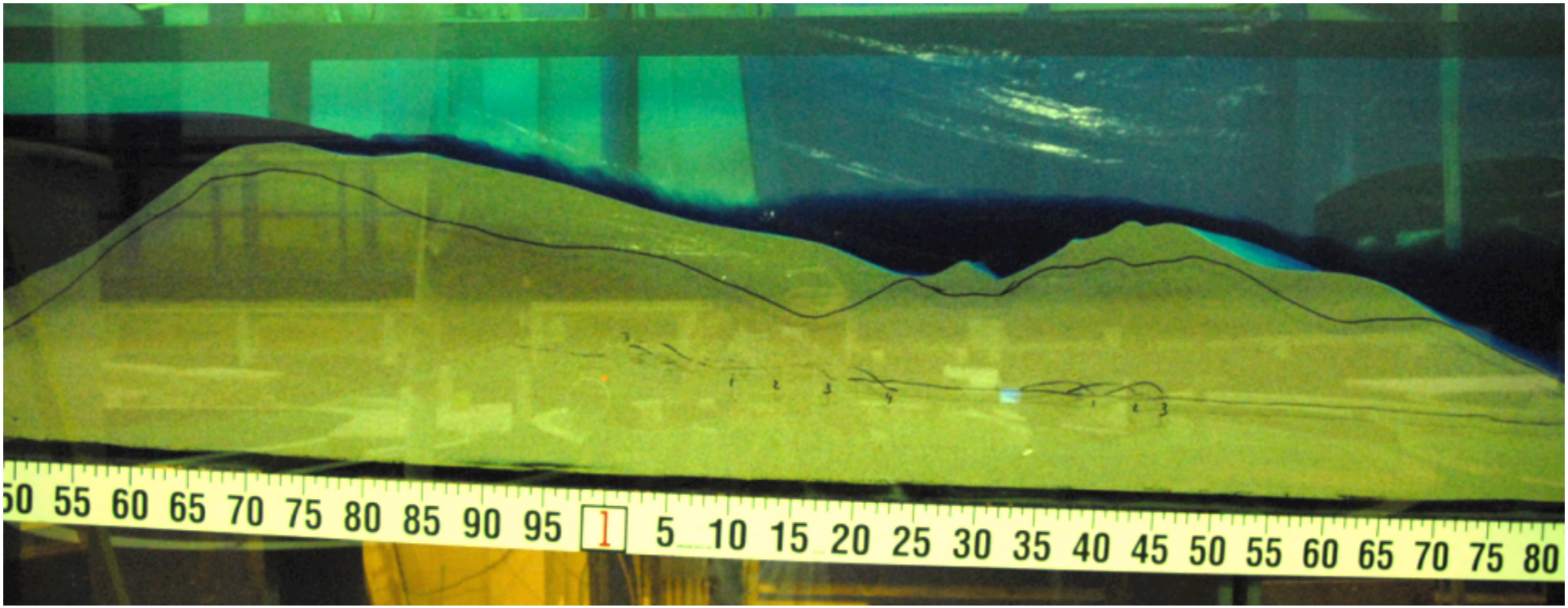


Toyama Deep Sea Channel:
Nakajima and Satoh (2001)



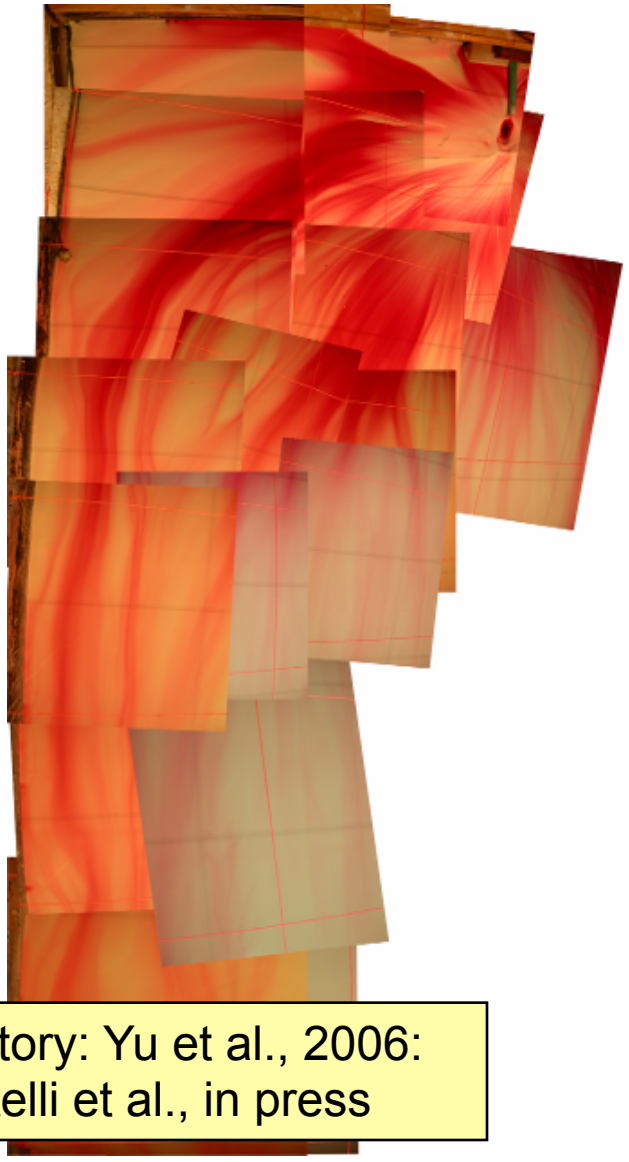
Zaire Submarine Channel: Babonneau et al. (2002)

SEDIMENT WAVES/CYCLIC STEPS IN THE LABORATORY

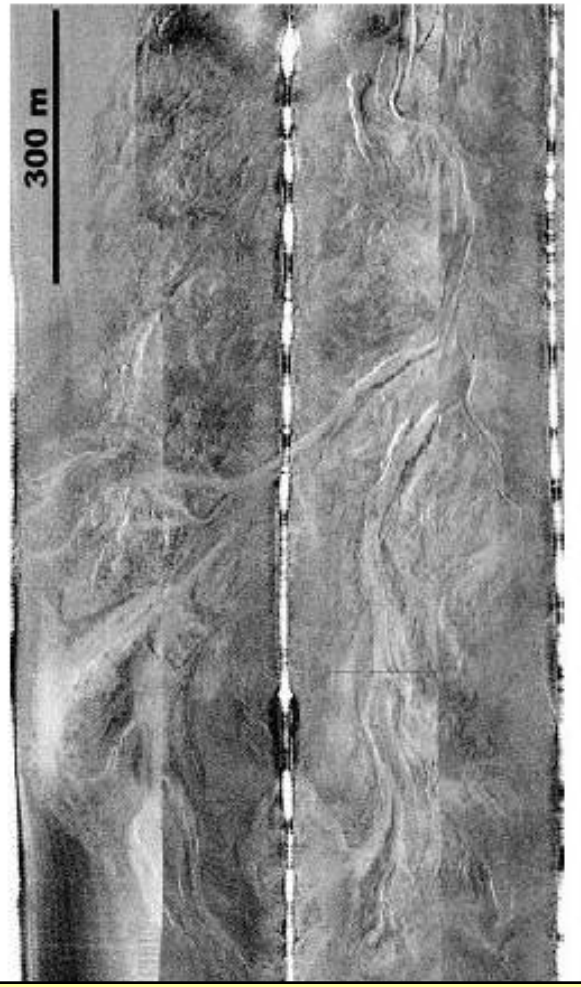


Spinewine et al. 2010

PATHWAYS AND MORPHOLOGIES: DISTAL END OF SUBMARINE FANS

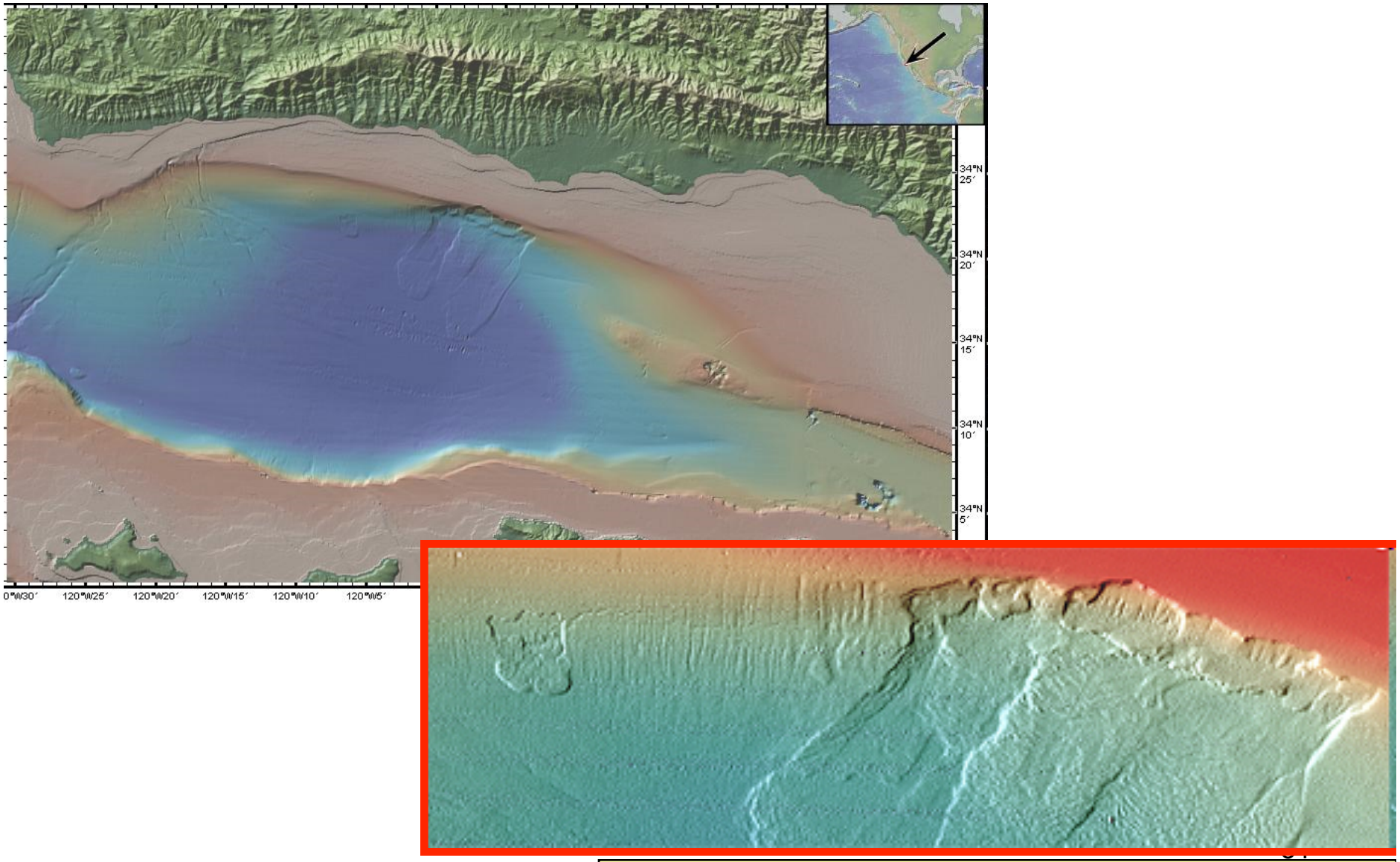


Laboratory: Yu et al., 2006: Cantelli et al., in press



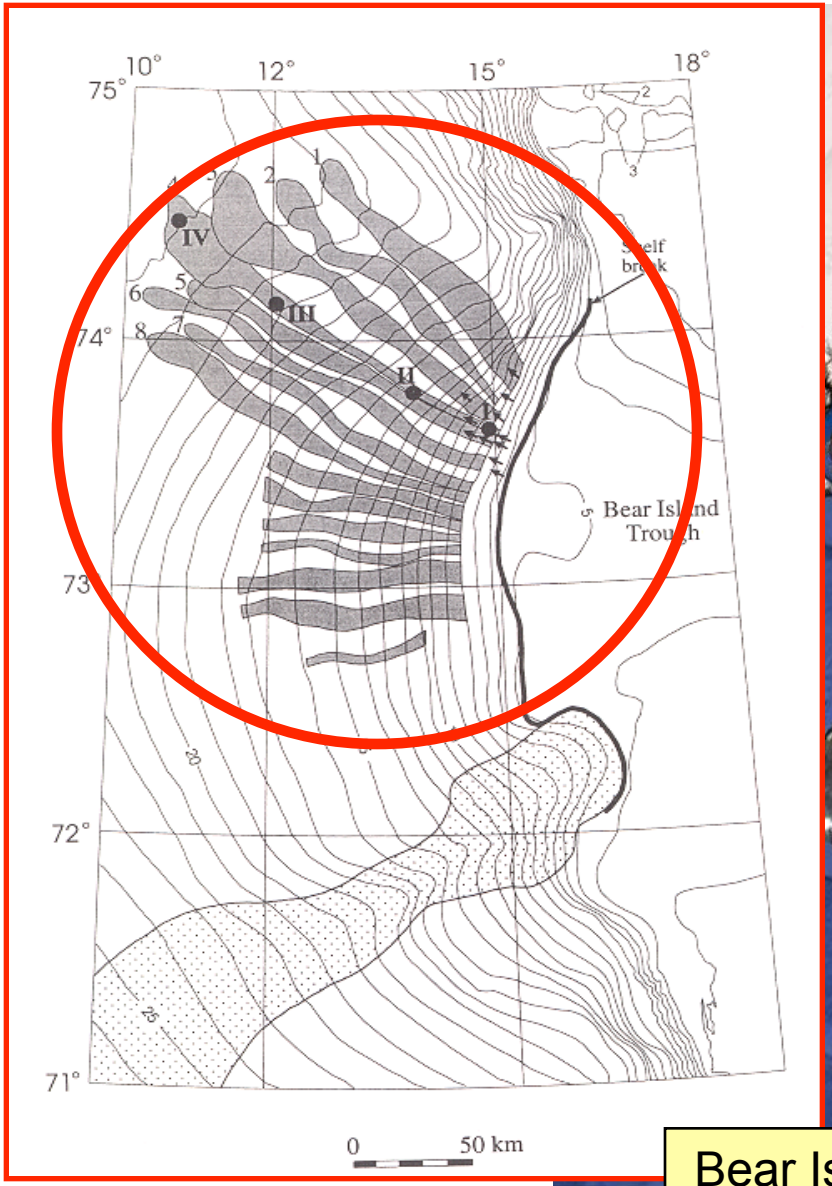
Pochnoi Submarine Fan, Kenyon & Millington, 1995

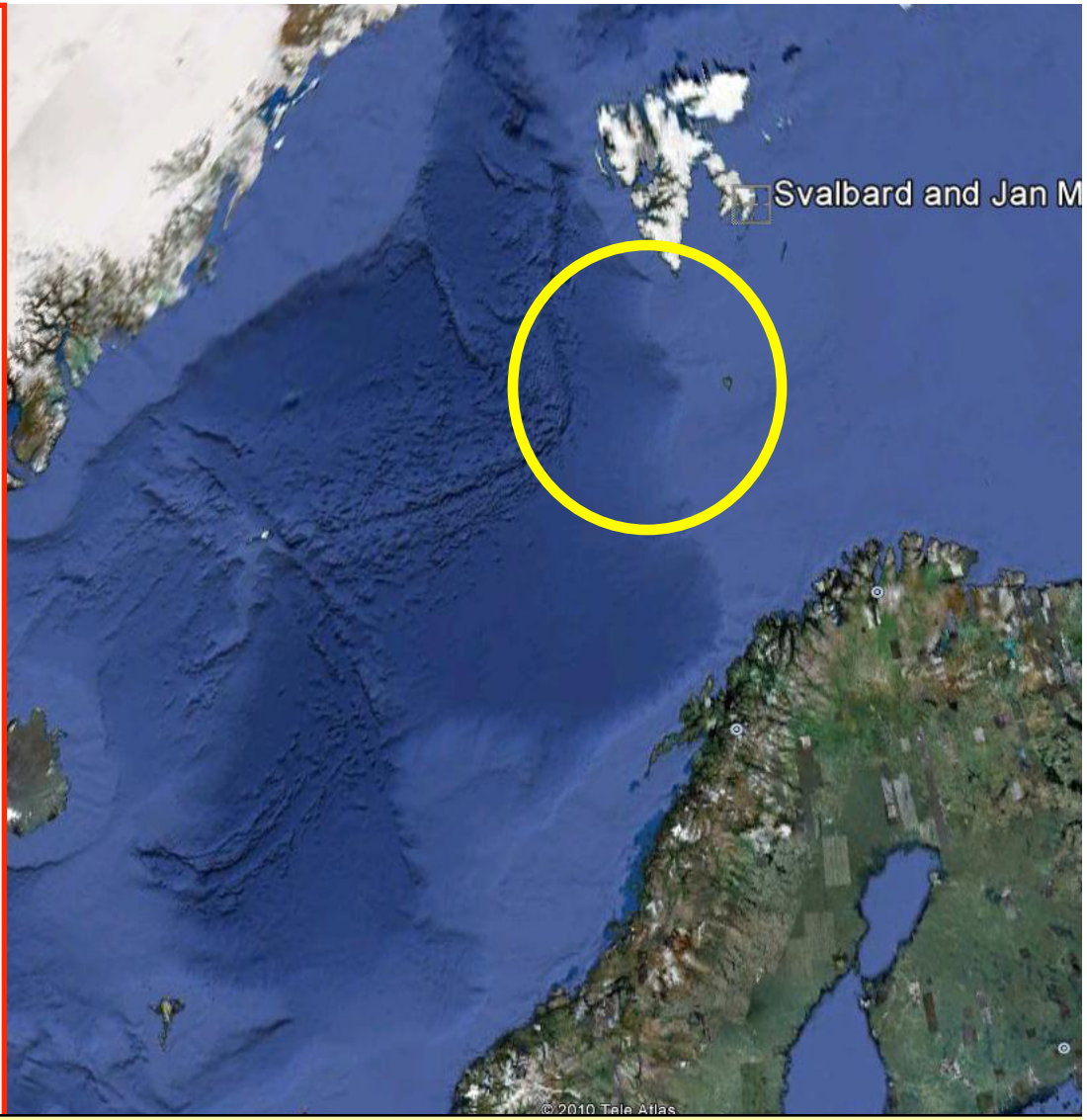
PATHWAYS AND MORPHOLOGIES: SHORT- AND LONG-RUNOUT SUBMARINE DEBRIS FLOWS



Goleta Submarine Failure: cour. MBARI

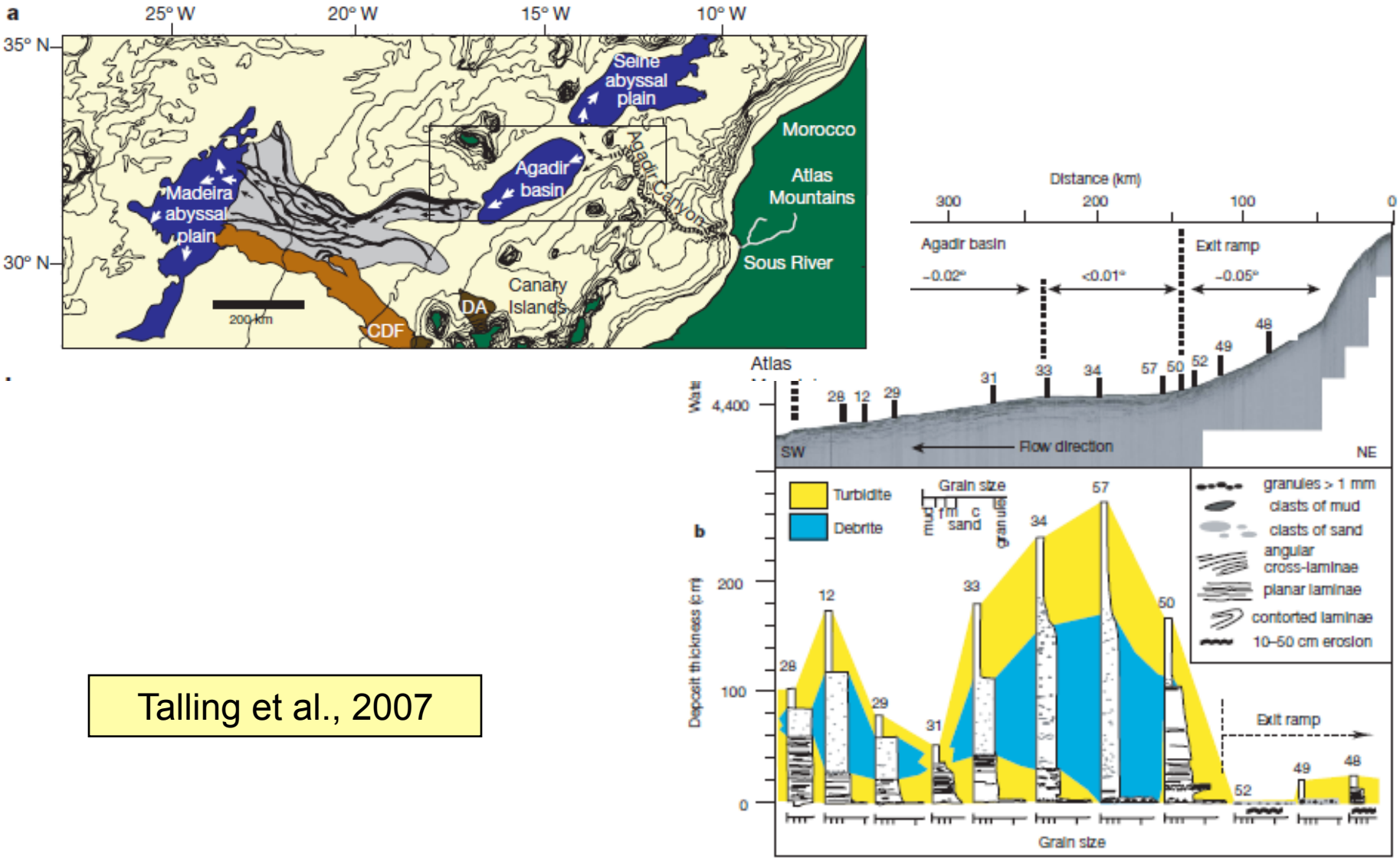
PATHWAYS AND MORPHOLOGIES: SHORT- AND LONG-RUNOUT SUBMARINE DEBRIS FLOWS





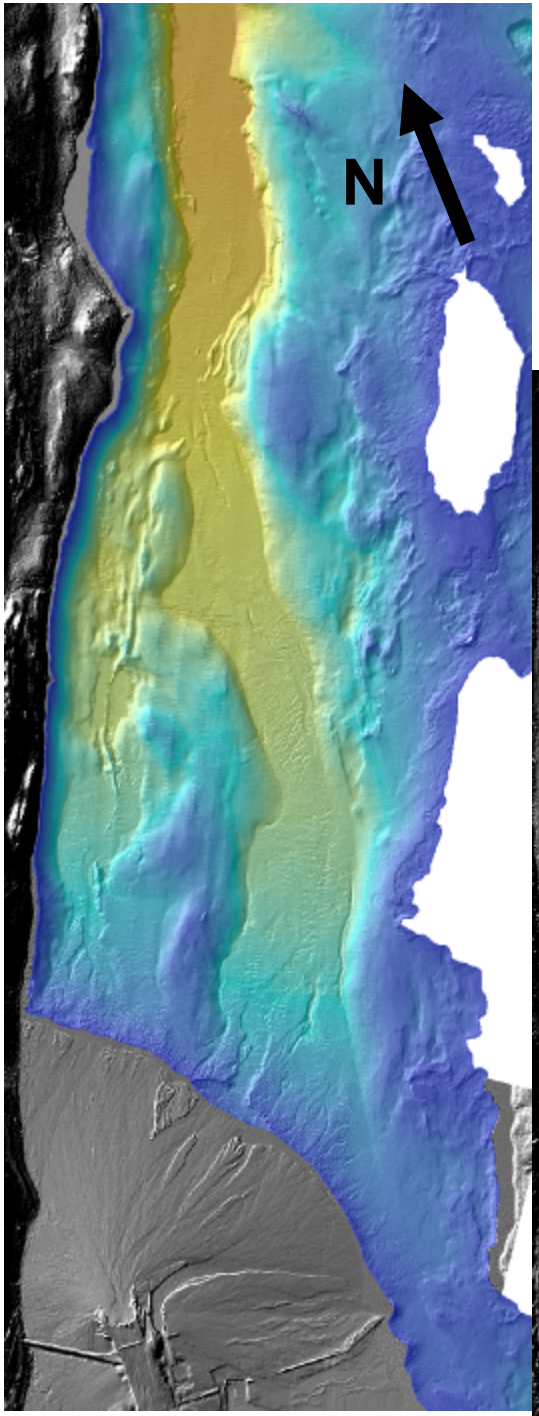
Bear Island Trough Mouth Fan: Laberg and Vorren, 1994

PATHWAYS AND MORPHOLOGIES: THE AGADIR DEPOSITS: SUBMARINE DEBRIS FLOWS OR TURBIDITY CURRENTS?

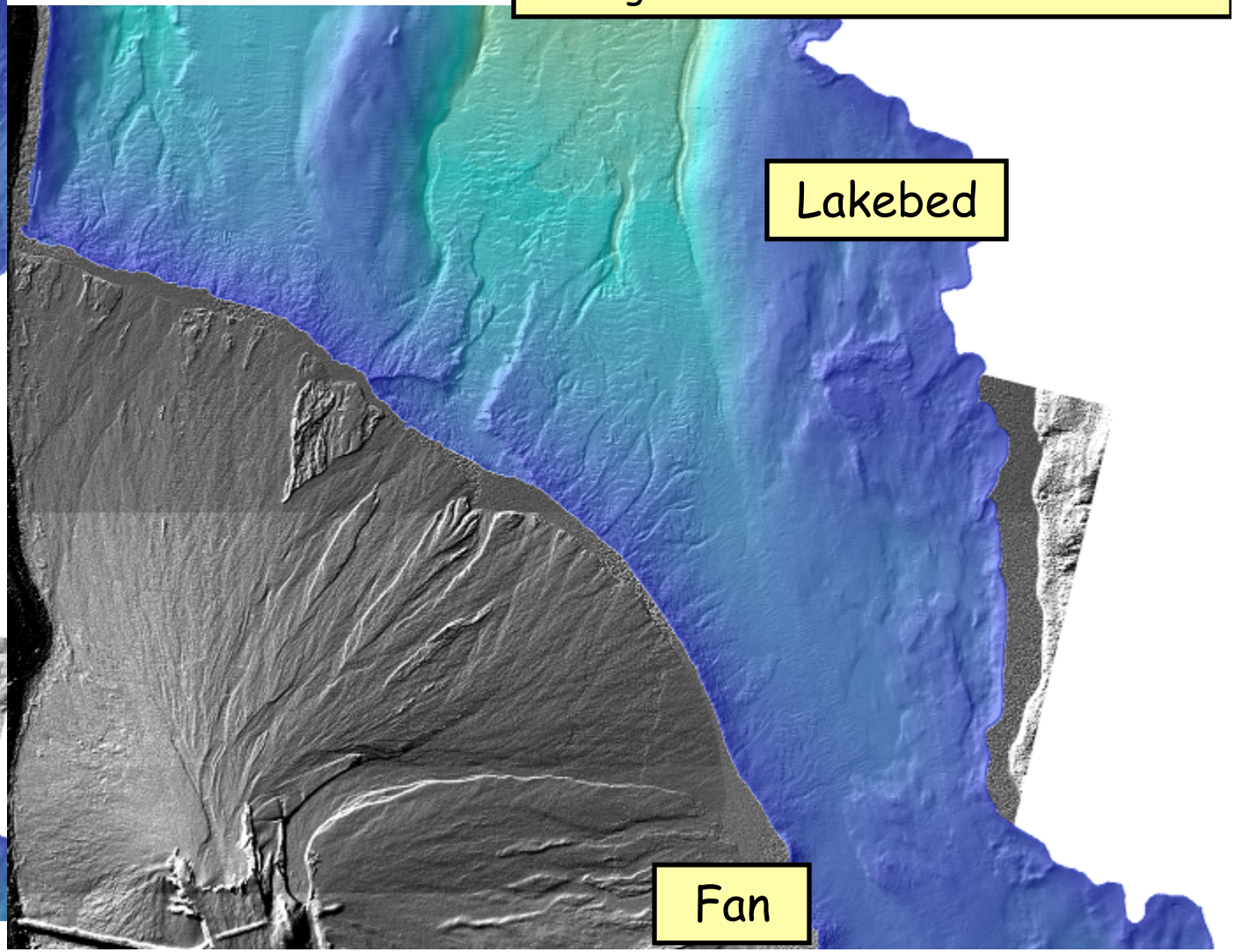


Talling et al., 2007

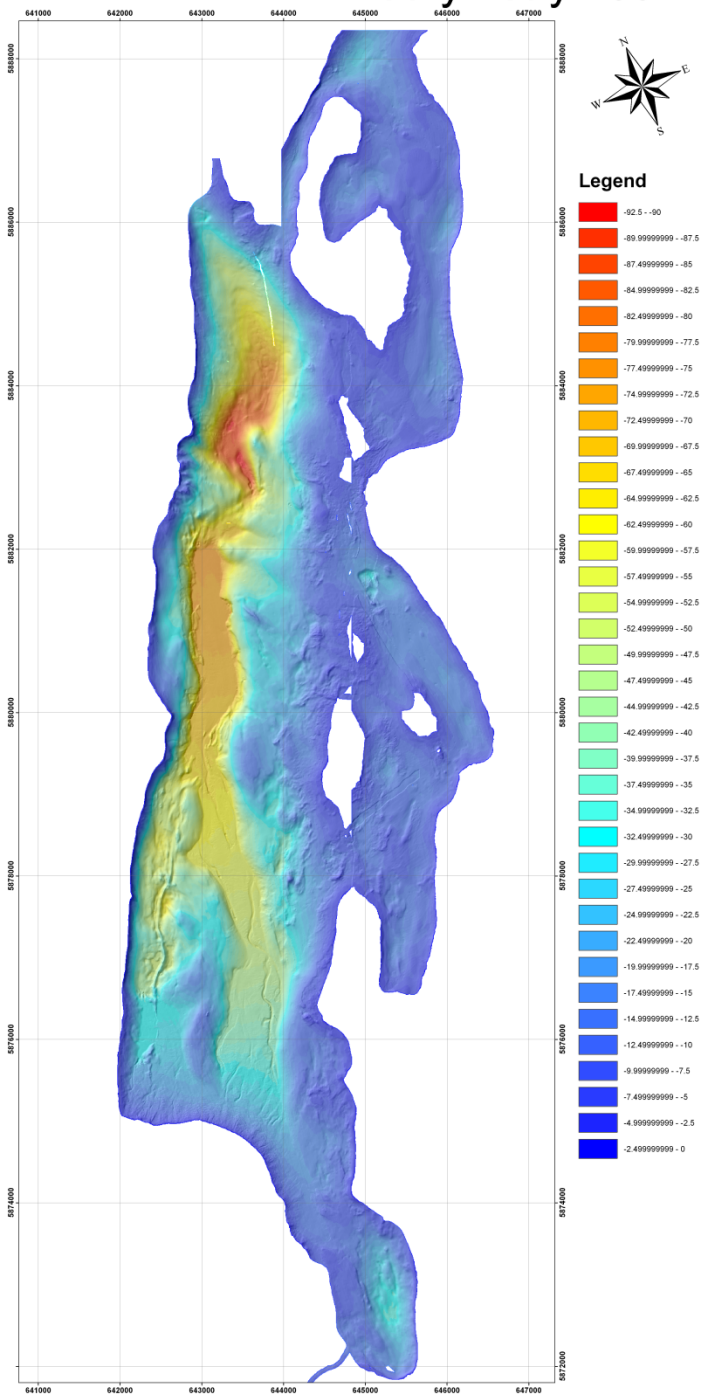
LAKE WABUSH:
A SMALL BUT COMPLETE SOURCE TO SINK SYSTEM AS OF 2008

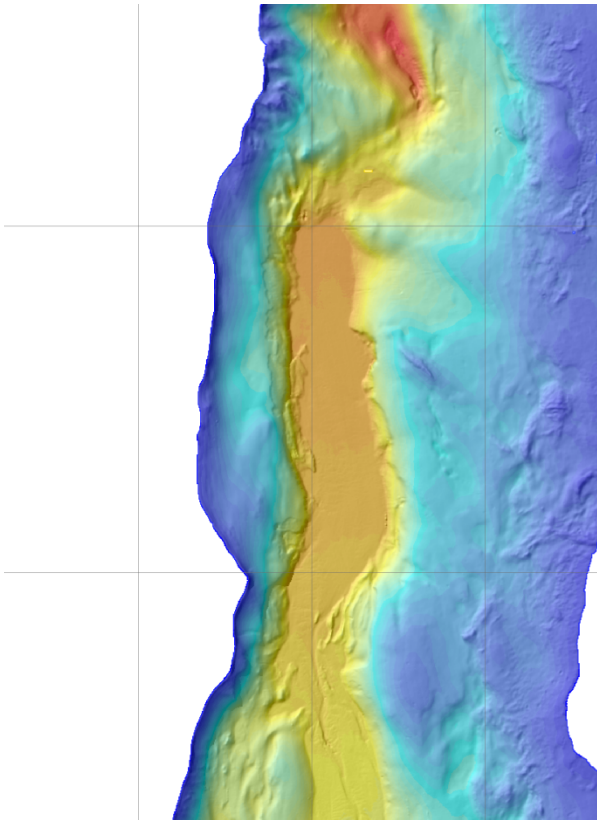


Images cour. D. Turmel and J. Locat

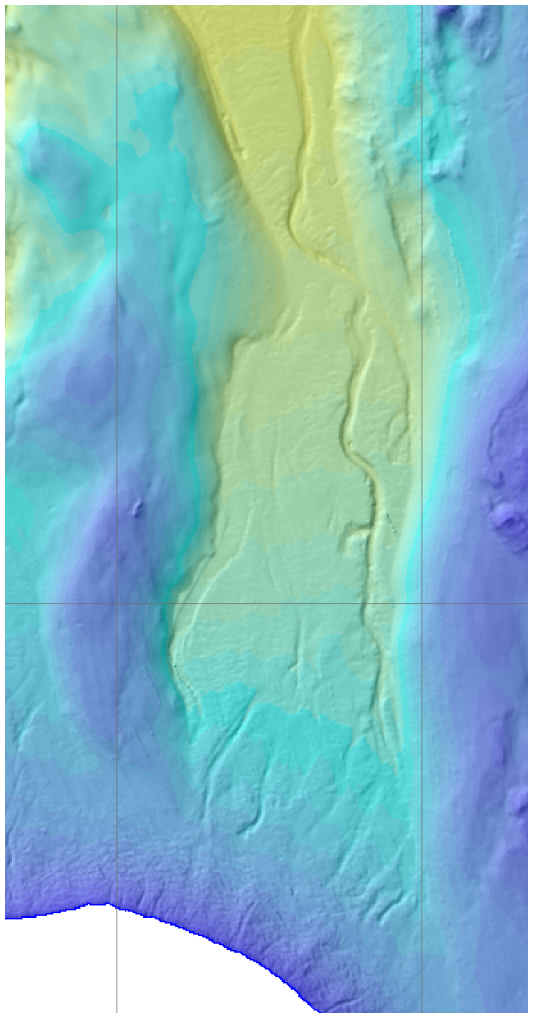


Bathymetry 2004



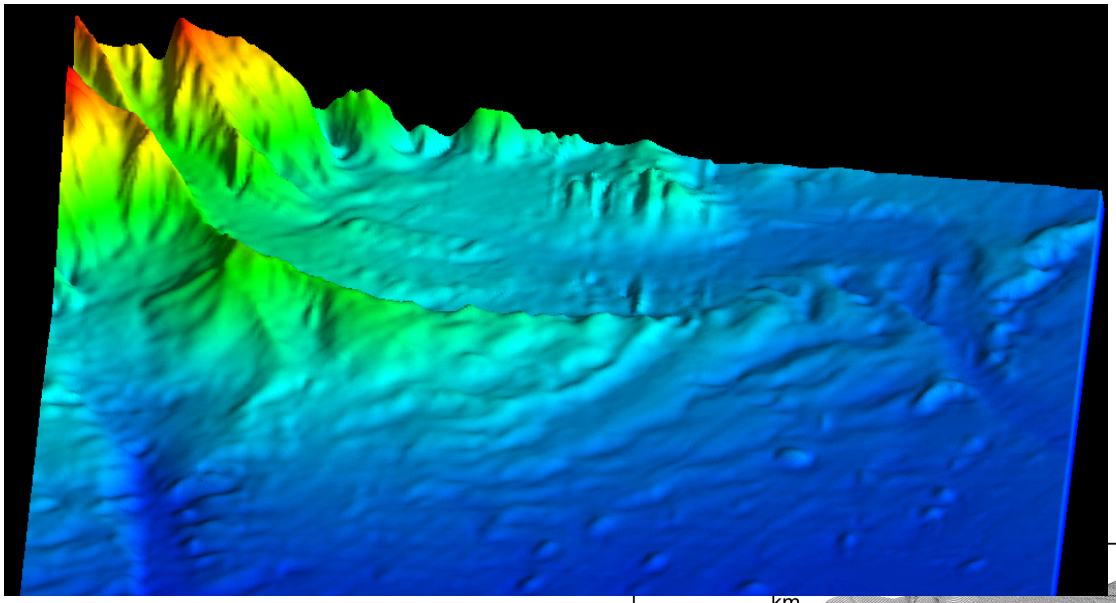


Minibasin



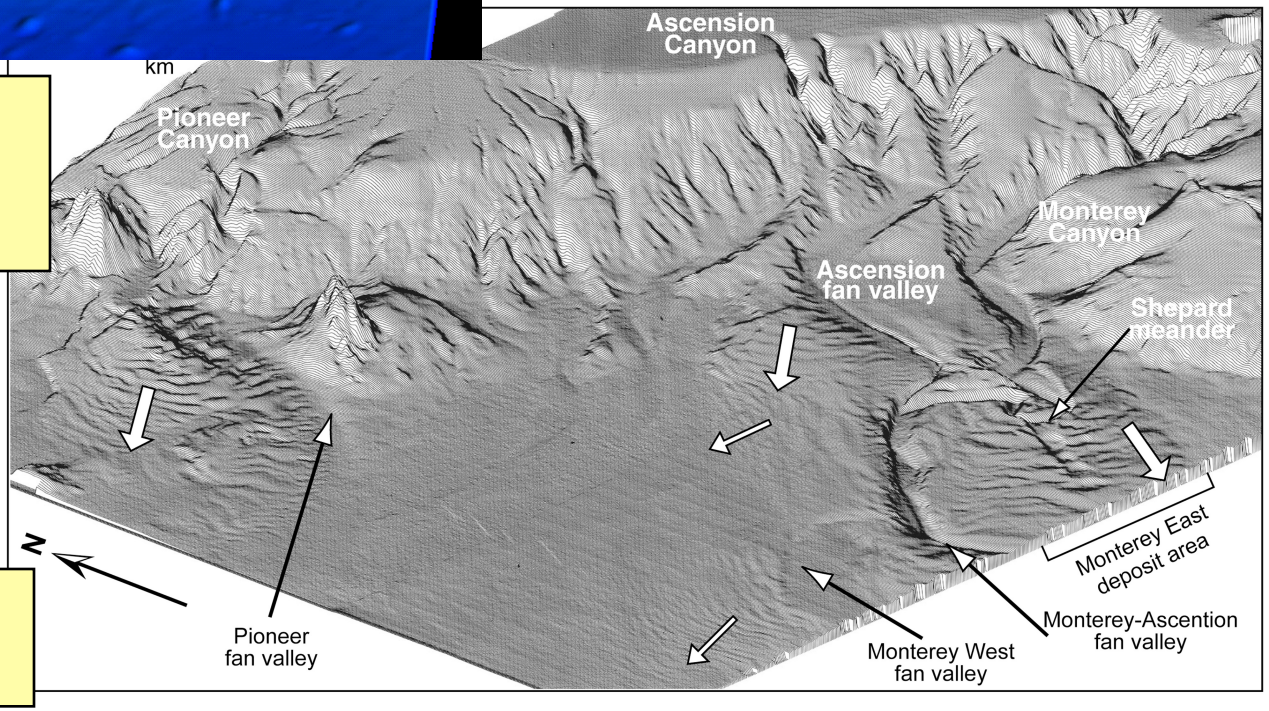
Meandering channel

THANK YOU FOR LISTENING



In memory of Bill Normark and Bruno Savoye

Var Sedimentary Ridge of Southern France; cour. B. Savoye



California Margin: cour. B. Normark